UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

August 29,2006

In response refer to:
2006/00041

E. Scott Clark
Chief, Planning Division
United States Army Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

Dear Mr. Clark:

This document transmits NOAA's National Marine Fisheries Service's (NMFS) biological opinion (Enclosure 1) based on our review of the proposed Sacramento Deep Water Ship Channel (SDWSC) Maintenance Dredging and Bank Protection project in Contra Costa, Sacramento, Solano, and Yolo Counties, California, and its effects on Federally listed endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), threatened Central Valley steelhead (*O. mykiss*), threatened southern distinct population segment (DPS) of North American green sturgeon (*Acipenser medirostris*), and the designated critical habitat of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*). Your April 15, 2005, request for formal consultation was received on April 19, 2005. Formal consultation was reinitiated on January 23, 2006.

This biological opinion is based on information provided in the March 2004 Biological Assessment, April 2005 Supplemental Information for the Biological Assessment, and discussions held at meetings with representatives of NMFS and the U.S. Army Corps of Engineers (Corps). A complete administrative record of this consultation is on file at the NMFS Sacramento Area Office.

Based on the best available scientific and commercial information, the biological opinion concludes that this project is not likely to jeopardize the continued existence of the listed species or destroy or adversely modify their designated critical habitat. NMFS also has included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to minimize incidental take associated with the SDWSC Maintenance Dredging and Bank Protection project. The section 9 prohibitions against taking of listed species and the terms and conditions in the incidental take statement of this biological opinion will not apply to North American green sturgeon until the final section 4(d) ruling under the ESA has been published in the Federal Register.

Also enclosed are Essential Fish Habitat (EFH) conservation recommendations for Pacific salmon as required by the Magnuson-Stevens Fishery Conservation and Management Act

(MSA) as amended (16 U.S.C. 1801 *et seq.*; Enclosure 2). This document concludes that the SDWSC Maintenance Dredging and Bank Protection project will adversely affect the EFH of Pacific salmon in the action area and adopts certain terms and conditions of the incidental take statement and the ESA conservation recommendations of the biological opinion as the EFH conservation recommendations.

Section 305(b)4(B) of the MSA requires the Corps to provide NMFS with a detailed written response within 30 days, and 10 days in advance of any action, to the EFH conservation recommendations, including a description of measures adopted by the Corps for avoiding, minimizing, or mitigating the impact of the project on EFH (50 CFR §600.920[j]). In the case of a response that is inconsistent with our recommendations, the Corps must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, or mitigate such effects.

If you have any questions regarding this correspondence please contact Mr. John Baker in our Sacramento Area Office, 650 Capitol Mall, Suite 8-300, Sacramento, California 95814. Mr. Baker may be reached by telephone at (916) 930-3616 or by Fax at (916) 930-3629.

Sincerely,

Russell M Strach

fr Rodney R. McInnis
Regional Administrator

Enclosures (2)

cc: Copy to file – ARN 151422SWR200600041
NMFS-PRD, Long Beach, California

Enclosure 1

BIOLOGICAL OPINION

ACTION AGENCY: U.S. Army Corps of Engineers, Sacramento District

ACTIVITY: Sacramento Deep Water Ship Channel Maintenance Dredging and Bank Protection project

CONSULTATION CONDUCTED BY: NOAA's National Marine Fisheries Service

PCIS TN: 2006/00041

DATE ISSUED: August 29, 2006

I. CONSULTATION HISTORY

On January 29, 2003, John Baker and Jeff Stuart of NOAA's National Marine Fisheries Service (NMFS) met with Jim Sanders, Randy Olsen, and Monica Eichler of the U.S. Army Corps of Engineers (Corps), Sacramento District to discuss NMFS's process and informational requirements for consultation under section 7 of the Endangered Species Act (ESA) on the Corps maintenance dredging activities for the Sacramento Deep Water Ship Channel (SDWSC) and Stockton Deep Water Ship Channel. On March 25, 2004, the Corps submitted a biological assessment (BA) to NMFS and requested concurrence that the proposed maintenance dredging and bank stabilization work on the SDWSC was not likely to adversely affect listed species or critical habitat. On May 5, 2004, NMFS responded to the Corps request with a finding that all information necessary to concur with the Corps determination had not been provided. Additional information was requested including identification of individual reaches to be dredged and maintenance dredging cycles, sediment analysis data, water quality analysis data for both dredging operations and effluent return from dredged material placement (DMP) sites, a description of the specific areas to be affected directly or indirectly, and a description of the manner in which the action may affect listed species or designated critical habitat. On April 17, 2005, NMFS received the requested information. NMFS responded to the Corps request and initiated formal consultation on May 4, 2005. NMFS requested additional information from the Corps to describe the fisheries monitoring and water quality monitoring programs included in the Corps' project description. Final drafts of the plans for the fisheries monitoring and water quality monitoring programs have not been completed; therefore, NMFS has analyzed the effects of the project without relying on monitoring efforts to avoid or minimize effects on listed species.

The Corps reinitiated consultation with NMFS with a request to change the project description on January 23, 2006. Specifically, the dredging period was changed to June 1 through February 27 of each dredging year through 2014; and, dredging from December 1 through February 27 consistent with those described in the Corps BA and supplemental information to the BA delivered on August 20, 2004.

This biological opinion is based on information provided in the biological assessment, supplemental information for the biological assessment, and discussions between John Baker and Jeff Stuart of NMFS and Jim Sanders, Randy Olsen, Monica Eichler, Kimberly Moir, Michael Dietl, and Edward Stewart of the Corps. A complete administrative record of this consultation is on file at the NMFS Sacramento Area Office.

II. DESCRIPTION OF THE PROPOSED ACTION

The Corps proposes to perform routine maintenance dredging and bank protection on the SDWSC yearly during the 10 dredging seasons from 2006 to 2015. These actions are authorized by the Rivers and Harbors Act of July 24, 1946 (Public Law 525, 79th Congress, 2nd Session). Additional authorization is given by "An Act Making Supplemental Appropriations for the Fiscal Year Ending September 30, 1985, and for Other Purposes," as contained in Public Law 99-88 dated August 15, 1985.

The SDWSC is an artificial channel created in 1963 to accommodate deep-draft ocean going vessels from Suisun Bay to an inland harbor at West Sacramento. It consists of two sections, Suisun Bay through Cache Slough (lower section), and Cache Slough to West Sacramento (upper section). The lower section is approximately 18.6 miles long and is largely within the main channel of the lower Sacramento River. The upper section is entirely man-made and bisects a 25-mile long area east of Cache Slough and west of the Sacramento River. The upper section consists of the ship channel, a triangular harbor and turning basin called Washington Lake, and a barge canal including the W.G. Stone navigation lock which extends from the harbor to the Sacramento River for transfer of barges between waterways. Regular operation of the lock in West Sacramento ceased in 1982 when it was put into caretaker status due to low commercial use. In 2000, the Corps de-authorized the lock, only spending funds on the facility for reasons of public safety. The lock is currently in closed position.

A. Project Activities

1. <u>Dredging</u>

The proposed maintenance dredging is intended to maintain the SDWSC at a depth of 30 feet through most of the channel (as measured at the mean lower low water diel tidal cycle). Sections located within 9 miles of the Port of Sacramento are maintained at a depth of 35 feet. The SDWSC invert width (*i.e.*, width at the channel bottom) varies from 250 to 400 feet. The dredging work window will follow a yearly schedule between June 1 and February 27 of each dredging year through 2015. Dredging from December 1 through February 27 will be conducted only in the upper section of the SDWSC that is located outside of the Sacramento River and

Cache Slough. The historical average dredging cycles for the SDWSC are summarized by reach in Table 1.

Table 1. Average Dredging Cycles for Sacramento River Ship Channel reaches.

Reach (river mile)	Dredging Cycle (years)
3.5 to 15	6
4 to 7	6
9 to 15	7
26 to 35	11
33 to 43	15

Such cycles are only averages so dredging in any reach may occur in any given year because depositional mechanisms are not predictable and maintenance dredging usually occurs every year. The reach sequence for dredging will be specified for each year. Unless otherwise specified, dredging will start at the most downstream reach and continue sequentially to the most upstream reach. Dredging within a reach may continue in any direction provided it is done in a progressive and complete manner (Corps 2003b).

Dredging is performed using a 2,000-horsepower hydraulic cutterhead suction dredge (also called a pipeline dredge), with a 16-inch-diameter discharge pipe. Future maintenance dredging may employ smaller or larger dredges in terms of size, although there is a regulatory limit on dredge size. The size limit is due to requirements for achieving acceptable settling time on the DMP sites to meet the water quality requirements of the Central Valley Region of the California Regional Water Quality Control Board (RWQCB). The quantity of material dredged each season normally will not exceed 500,000 cubic yards. However, dredge material quantities following monumental flood events may be larger. The quantity of material to be dredged each working day during maintenance dredging operations will not exceed 8,576 cubic yards (*i.e.*, a 16-inch dredge pumping 6,944 gallons per minute, which corresponds with the 10 million gallons per day (mgd) limit set by the Waste Discharge Requirements (WDR) General Order issued by the RWQCB; Corps 2003a). The dredge will operate 24 hours per day, 7 days per week during the dredging cycle.

The dredge is moved to different reaches by tugboat or under its own power. Typically, the dredge is tended by two tenders of the 750-horsepower class that pick up and place the swing anchors as the dredge progresses. The tenders also can move the dredge short distances. Additionally, two outboard engine-powered skiffs transport crews and conduct water sampling upstream and downstream of the dredge.

When the dredge is positioned in a location where shoaling is to be removed, the dredge anchors itself by alternately planting one of two spuds, or vertical poles, into the bottom sediment. The spuds are located at the stern of the dredge. The dredge rotates around whichever of the two spuds is planted in the bottom by pulling on “swing” anchors that have been planted on either side of the river ahead of the dredge, alternately raising the planted spud and planting the other one as the dredge "walks" forward. The hydraulic pipeline cutterhead dredge is equipped with a rotating cutterhead (excavator) surrounding the intake of the suction line. The cutter excavates and transfers the substrate materials into the influence of the high velocity water (no more than 11 feet per second) at the suction intake to the dredge's centrifugal pump. At this point, the solids and a large volume of water from the surrounding water column are entrained, passed through the dredge centrifugal pump to a 16-inch-diameter discharge pipeline, and discharged onto the relevant upland DMP sites as a slurry. The slurry typically has a solids content of 10 to 15 percent by weight (Corps 2003a). Dredging will be limited to depths greater than 20 feet, and the cutterhead will be kept within 3 feet of the channel bottom when drawing in water.

The dredge contractor along with a qualified biologist will decide the best route for the pipeline to avoid special status species or habitat. The pipeline will be marked with buoys to warn boaters of its presence. The dredge operator will be responsible for controlling the ratio of water to dredged material that is drawn into the pipe.

2. <u>Dredged Material Placement Sites</u>

The DMP sites used for any given reach are determined by the distance which dredged material can be pumped. This normally restricts the location of the DMP sites to within 3 miles of the dredging site. The DMP sites that potentially will be used for dredging in the SDWSC are identified in Table 2.

Each DMP site is sized to allow enough retention time for the dredged material to settle before decanting the water back into the river pending approval from the RWQCB. The DMP site may also contain internal dikes to promote settling and prevent short-circuited flow from the dredged material entry point to the outfall. The effluent placed onto the DMP site, with the dredged material, can leave by means of percolation and evaporation; transport into on-site drainage ditches and subsequent pumping into the river; or collection at a low point, and subsequent pumping into the river without mixing with the on-site drainage ditch water. If discharge of dredge water is required, the water not lost to evaporation or percolation will be returned to the river after it has spent between 1.5 and 8 days on the DMP site. The effluent decant water will be returned to the river channel at a rate of approximately 8,073 mgd, assuming 15 percent solids by volume, and monitored as required by DWR. Under these conditions, the discharge rate is expected to be no more than 12.5 cubic feet per second (cfs) since some of the water percolates downward.

Dredged material from the ship channel, on a mass weighted basis, is expected to be composed of various quantities of sand, silt, and clay. Dredged material placed into DMP sites will be allowed to decant and dry. The DMP sites can then be returned to their original uses, which include production of nonfood crops, or the material can be used for fill materials, reinforcing levees, or constructing wetland features.

Table 2. Sacramento Deep Water Ship Channel Dredged Material Placement Sites

Site Name (Number)	Approximate Size (acres)	Type of Effluent Return	Discharge to Water Body	Remarks
Lake Washington (S1)	124	Pump	Sacramento Ship Channel at CM[1] 43.4	Gravity effluent return not possible; site material is primarily sand and silt
Prospect Island (S-11)	640	Pump	Sacramento Ship Channel at CM 26	Gravity effluent return not possible; primarily farmland
Prospect Island (S-12)	320	Pump	Sacramento Ship Channel at CM 20	Gravity effluent return not possible
Grand Island (S-14)	196	Gravity drain. Effluent leaves by existing weir box and/or pump	Steamboat Slough	Elevated site; portion of site is heavily wooded
Rio Vista (S-16)	149	Gravity drain. Effluent leaves by existing weir box and/or pump	Sacramento River at CM 11	Elevated site; may have sand trucks hauling through site
Decker Island (S-19)	590	Gravity drain. Effluent leaves by existing weir box	Sacramento River at CM 7 (Horseshoe Bend)	Elevated site; material disposed on ongoing mining operation

		and/or pump		

Table 2 (Continued). Sacramento Deep Water Ship Channel Dredged Material Placement Sites.

Site Name	Approximate Size (acres)	Type of Effluent Return	Discharge to Water Body	Remarks
Augusto Pit (S-20)	98	Gravity drain; effluent leaves by agricultural ditch and/or pump	Sacramento River at CM 5	Site underlain by peat and clay
West Bank (S-31)	663	Gravity drain; effluent leaves site by existing weir boxes on portions of site and/or pump	Sacramento Ship Channel at CM 27 to 40	Long narrow site; portions of site are heavily vegetated with limited inundation permitted
East Bank (S-32)	265	Gravity drain. Effluent leaves by existing weir box and/or pump	Sacramento Ship Channel at CM 26.0 to 26.5	No berms present; some cells would require berm construction for use as DMP site

[1]Channel Mile (CM)

3. <u>Bank Stabilization</u>

Bank stabilization activities will take place during the period between June 15 and November 30, with all inwater work limited to the period between June 15 and September 30, each year for the 10-year duration of this opinion. This bank protection maintenance work will be located along both banks of the upper section (*i.e.*, manmade portion) of the SDWSC, upstream of approximately CM 18.6. Rock will only be placed at sites that previously contained bank protection work and where there is a need for additional rock due to bank erosion. Activities in shallow water habitats will be avoided to the fullest extent possible. However, proposed bank protection maintenance work may involve some shallow water areas.

Suitable rock protection will be placed at eroded sites on the waterside of the levees, as identified during annual inspections by the Corps. The location and size of bank protection maintenance work will be determined during annual inspections. If an erosion site no longer has evidence of pre-existing rock and therefore will require placing rock on a site with fish habitat in the form of riparian vegetation, the Corps will compensate as appropriate at a 3:1 ratio for the loss of any habitat values that have developed since the rock work washed away. The Corps will coordinate with NMFS during each year that bank protection maintenance occurs in areas requiring compensation.

Suitable rock for bank protection will be placed by mechanical means. This can include the use of a clamshell from a barge and crane in the river or from a dump truck and crane on the levee. All reasonable effort will be taken to avoid or minimize underwater placement of rock. Rock will be placed during low tide and below the line of ordinary high water. Stone used as bank protection will be placed in such a manner as to produce a reasonably well-graded mass with a minimum practicable percentage of voids. Rearranging of stones by a dragline may be required to obtain a reasonably well-graded distribution of stone sizes and to provide a finished surface free of protruding stones. Bulldozers or other equipment that cause degradation or displacement of stone will not be used on the slopes. Dumping of bank protection rock over the slope of the levee will not be permitted.

4. Interrelated and Interdependent Activities

No interrelated and interdependent activities have been identified for this project. Although the proposed project will maintain the SDWSC as a commercial shipping lane, no increase in the number of commercial vessel transits per day or vessel size is anticipated in the SDWSC for the foreseeable future; therefore, shipping impacts are considered only as part of the environmental baseline.

B. Proposed Conservation Measures

The following conservation measures are included as part of the project description:

1. Direct effects to listed Chinook salmon and steelhead by entrainment will be avoided by not operating the dredge when the cutterhead is off the river bottom. The cutterhead will be buried in the sediment of the river bed during maintenance dredging activities or raised no more than 3 feet off the river bottom when the pumps are operating.

2. The contractor will be responsible for providing erosion and sediment control measures in accordance with Federal, State, and local laws and regulations to ensure compliance with water quality standards. This will be accomplished by implementing temporary and permanent erosion and sediment control best management practices (BMPs). These may include, but are not limited to, use of vegetation cover, stream bank stabilization, slope stabilization, silt fences, earthen terraces, interceptor channels, sediment traps, inlet and outfall protection, diversion channels,

and sedimentation basins. Any temporary measures will be removed after the area has been stabilized (Corps 2003b).

3. A Corps representative will be identified as the point of contact for any contractor who might incidentally take a listed salmonid species, or find dead, injured, or entrapped listed salmonids. This point of contact will be identified to all construction employees during an orientation regarding the potential effects of the proposed action on listed Chinook salmon and steelhead. The orientation will be conducted by a qualified fisheries biologist and cover specific information on measures to prevent injury to listed fish and what to do if any are found in the project area.

4. NMFS will be notified immediately if a salmon or steelhead is found dead or injured. Follow-up written notification will include the date, time, and location of the dead or injured specimen, a photograph, cause of injury or death, and name and agency affiliation of the individual who found the specimen.

5. The Corps, through the dredging contractors, will minimize adverse effects to listed species associated with the loss of riparian habitat by mitigation, with no net loss of quantity or quality. This will be coordinated with NMFS.

6. Additional measures associated with hydraulic dredging include: reducing the cutterhead rotation speed (reduces the potential for side casting the excavated sediment and resuspending it); reducing the swing speed (ensures that the dredge head does not move through the cut faster than it can hydraulically pump the sediment, and thus reduces the volume of resuspended sediment); and eliminating bank undercutting (dredgers should remove the sediment in maximum lifts equal to 80 percent or less of the cutterhead diameter).

7. Dredging at depths less than 20 feet will be avoided.

8. Suction will not be employed as the dredge head is deployed and retrieved through the water column. The suction head will be maintained at a constant elevation near the channel bed when dredging to reduce the field of influence where fish may be entrained into the dredge pipe.

9. The pipelines will be kept in the deeper portions of the channel as much as possible to reduce the potential for the pipe to cause damage to wetland and riparian vegetation. The landing point of the dredge placement pipe will be fixed and secured along the shore.

10. Overflow from the dredge to the channel will not be allowed.

11. A drag beam or similar device to “knock down” ridges or high spots in the channel bottom will not be used.

12. The Corps proposes to draft and implement a monitoring plan to evaluate the nature and extent of effects on listed anadromous salmonids. The Corps Sacramento District’s maintenance

dredging program has not included fish monitoring during prior dredging seasons. Under the plan, a qualified fisheries biologist will perform real-time monitoring in the channel and/or at the point of discharge onto the relevant DMP sites during maintenance dredging work. Thus, a monitoring plan will allow the Corps to quantify the extent of incidental take caused by maintenance dredging activities. Monitoring will occur on an annual basis until sufficient confidence in the quantification of the level of take is developed, as approved by NMFS. Subsequent monitoring will occur if conditions become significantly different than those during the initial monitoring period.

C. Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR §402.02). The action area, for the purposes of this biological opinion, is the Sacramento River from RM 0 to 16 and Sacramento Deep Water Ship Channel, Montezuma Slough, Suisun Bay, Horseshoe Bend, Three Mile Slough, Steamboat Slough, Cache Slough, Miner Slough, Prospect Slough, and Babel Slough. This area was selected because it represents the extent of anticipated direct and indirect effects of project actions.

III. STATUS OF THE SPECIES AND HABITAT

This biological opinion analyzes the effects of SDWSC Maintenance Dredging and Bank Protection project on the following threatened and endangered Evolutionarily Significant Units (ESUs) and Distinct Population Segments (DPSs), and designated critical habitat:

Sacramento River winter-run Chinook salmon ESU
(*Oncorhynchus tshawytscha*; endangered; June 28, 2005, 70 FR 37160)

Sacramento River winter-run Chinook salmon designated critical habitat
(June 16, 1993, 58 FR 33212)

Central Valley spring-run Chinook salmon ESU
(*Oncorhynchus tshawytscha*; threatened; June 28, 2005, 70 FR 37160)

Central Valley spring-run Chinook salmon designated critical habitat
(September 2, 2005, 70 FR 52488)

Central Valley steelhead DPS
(*Oncorhynchus mykiss*; threatened; January 5, 2006, 71 FR 834)

Central Valley steelhead designated critical habitat
(September 2, 2005, 70 FR 52488)

Southern DPS of North American green sturgeon
(*Acipenser medirostris*; threatened; April 7, 2006, 71 FR 17757)

A. Species and Critical Habitat Listing Status

1. Sacramento River winter-run Chinook salmon

Sacramento River winter-run Chinook salmon (SR winter-run Chinook salmon) originally were listed as threatened in November 1990 (55 FR 46515). Their status was reclassified as endangered in January 1994 (59 FR 440) due to continued decline and increased variability of run sizes since their listing as a threatened species, expected weak returns as a result of two small year classes in 1991 and 1993, and continued threats to the population. In the proposed rule to reclassify the winter-run Chinook salmon as endangered, NMFS recognized that the population had dropped nearly 99 percent between 1966 and 1991, and despite conservation measures to improve habitat conditions, the population continued to decline (57 FR 27416). In June 2004, NMFS proposed to reclassify SR winter-run Chinook salmon as threatened (69 FR 33102). This determination was based on three main points: (1) harvest and habitat conservation efforts have increased the abundance and productivity of the Evolutionarily Significant Unit (ESU) over the past decade; (2) artificial propagation programs that are part of the ESU, the Captive Broodstock Programs at Livingston Stone National Fish Hatchery and at the University of California Bodega Marine Laboratory contribute to the ESU's viability; and (3) California-Federal (CALFED) Bay-Delta Authority (CBDA) ecosystem restoration plans underway in Battle Creek should provide the opportunity to establish a second winter-run Chinook salmon population. However, on June 28, 2005, after reviewing the best available scientific and commercial information, NMFS issued its final decision to retain the status of SR winter-run Chinook salmon as endangered (70 FR 37160). This decision was based on the continued threats to SR winter-run Chinook salmon and the continued likelihood of this ESU becoming extinct throughout all or a significant portion of its range. A draft recovery plan was published in August 1997 (NMFS 1997).

Winter-run Chinook salmon historically spawned in the headwaters of the McCloud, Pit, and Little Sacramento Rivers and Hat and Battle Creeks. Construction of Shasta Dam in 1943 and Keswick Dam in 1950 blocked access to all of these waters except Battle Creek, which has been severely impacted by hydroelectric facilities and the Coleman National Fish Hatchery (Moyle *et al.* 1989, NMFS 1997). The majority of the current winter-run Chinook salmon spawning and rearing habitat exists on the main channel Sacramento River between Keswick Dam and Red Bluff Diversion Dam (RBDD). Although a small, unknown, number of winter-run Chinook salmon occasionally spawn in Battle and Clear Creeks, the ESU is widely considered to be reduced to a single naturally spawning population in the main channel Sacramento River below Keswick Dam.

Following the construction of Shasta Dam, the number of winter-run Chinook salmon initially declined but recovered during the 1960s. This initial recovery was followed by a steady decline from 1969 through the late 1980s (U.S. Fish and Wildlife Service (USFWS) 1999).

Adult winter-run Chinook salmon enter San Francisco Bay from November through June (Hallock and Fisher 1985) and migrate past RBDD from mid-December through early August (NMFS 1997). The majority of the run passes RBDD from January through May, and peaks in mid-March (Hallock and Fisher 1985). Generally, winter-run Chinook salmon spawn from near Keswick dam downstream to Red Bluff, California. The largest concentrations of spawning fish occur in the first 5 to 10 miles below Keswick Dam. Spawning occurs from late April through mid-August with peak activity between May and June. Eggs and pre-emergent fry require water temperatures at or below 56 ^{o}F for maximum survival during the spawning and incubation periods (USFWS 1999). Fry emerge from mid-June through mid-October and move to river margins and tributary streams to rear. Emigration past RBDD may begin in mid-July and typically peaks in September and can continue through March in dry years (Vogel and Marine 1991, NMFS 1997). From 1995 to 1999, all winter-run Chinook salmon outmigrating as fry passed RBDD by October, and all outmigrating pre-smolts and smolts passed RBDD by March (Martin *et al.* 2001).

Construction of RBDD in 1966 enabled improved accuracy of population estimates as salmon passed through fish ladders. From 1967 to 2000, winter-run Chinook salmon estimates were extrapolated from adult counts at RBDD ladders. Recent operational changes at RBDD have allowed a majority of the winter-run Chinook salmon population to bypass the ladders and counting facilities, and have increased the error associated with extrapolating the population estimate. Beginning in 2001, carcass counts replaced the ladder count to reduce the error associated with the estimate.

Since 1967, the estimated adult winter-run Chinook salmon population ranged from 186 in 1994 to 117,808 in 1969 (CDFG 2002). The estimate declined from an average of 86,000 adults in 1967-1969 to only 2,000 by 1987-1989, and continued downward to an average 830 fish in 1994-1996. Since then, estimates have increased to an average of 3,136 fish for the period of 1998-2001. Winter-run abundance estimates and cohort replacement rates since 1986 are shown in Table 3. Although the population estimates display broad fluctuation since 1986 (186 in 1994 to 9,757 in 2003), there has been an increasing average population trend since 1995, and a generally stable trend in the 5-year moving average of cohort replacement rates. The 2003 run was the highest since the listing, with an estimate of 9,757 adult fish.

Table 3. Winter-run Chinook salmon population estimates from RBDD counts, and corresponding cohort replacement rates for the years since 1986 (CDFG 2004a, CDFG 2004c).

Year	Population Estimate (RBDD)	5-Year Moving Average of Population Estimate	Cohort Replacement Rate	5-Year Moving Average of Cohort Replacement Rate
1986	2,596	-	-	-
1987	2,186	-	-	-
1988	2,885	-	-	-

1989	696	-	0.27	-
1990	433	1,759	0.20	-
1991	211	1,282	0.07	-
1992	1,240	1,092	1.78	-
1993	387	593	0.90	0.64
1994	186	491	0.88	0.77
1995	1,297	664	1.05	0.94
1996	1,337	889	3.45	1.61
1997	880	817	4.73	2.20
1998	3,002	1,340	2.31	2.48
1999	3,288	1,961	2.46	2.80
2000	1,352	1,972	1.54	2.90
2001	8,224	3,349	2.74	2.76
2002	7,441	4,661	2.26	2.22
2003	8,218	5,705	6.08	3.02
2004	7,701	6,587	0.94	2.71
2005	15,730	9,463	2.11	2.83

2. Central Valley Spring-Run Chinook Salmon

NMFS listed the Central Valley spring-run Chinook salmon (CV spring-run Chinook salmon) ESU as threatened on September 16, 1999 (64 FR 50394). In June 2004, NMFS proposed that CV spring-run Chinook salmon remain listed as threatened (69 FR 33102). This proposal was based on the recognition that, although CV spring-run Chinook salmon productivity trends are positive, the ESU continues to face risks from having a limited number of remaining metapopulations (*i.e.*, three existing populations from an estimated 17 historical populations), a limited geographic distribution, and potential hybridization with Feather River Hatchery (FRH) spring-run Chinook salmon, which until recently were not included in the ESU and are genetically divergent from other metapopulations in Mill, Deer, and Butte Creeks. On June 28, 2005, after reviewing the best available scientific and commercial information, NMFS issued its final decision to retain the status of CV spring-run Chinook salmon as threatened (70 FR 37160). This decision also included the FRH spring-run Chinook salmon population as part of the CV spring-run Chinook salmon ESU.

The decision to include the FRH population was based on several factors: (1) FRH spring-run Chinook salmon are no more divergent from the naturally spawning population in the Feather River than would be expected between two closely related populations in the ESU; (2) NMFS believes the early run timing of spring-run Chinook salmon in the Feather River represents the evolutionary legacy of the populations that once spawned above Oroville Dam, and that the extant population in the Feather River may be the only remaining representative of this ESU component; (3) the California Department of Water Resources (CDWR) is planning to construct a weir to create geographic isolation for spring-run Chinook in the Feather River to minimize future hybridization with fall-run Chinook salmon, and to preserve the early run timing phenotype, and (4) the FRH spring-run Chinook salmon may play an important role in the recovery of spring-run Chinook salmon populations in the Feather and Yuba Rivers.

Historically, spring-run Chinook salmon were the dominant run in the Sacramento River basin, occupying the middle and upper elevation reaches (1,000 to 6,000 feet) of most streams and rivers with sufficient habitat for over-summering adults (Clark 1929). Clark estimated that there were 6,000 miles of salmon habitat in the Central Valley basin (much of which was high elevation spring-run Chinook salmon habitat) and that by 1928, 80 percent of this habitat had been lost. Yoshiyama *et al.* (1996) determined that, historically, there were approximately 2,000 miles of salmon habitat available prior to dam construction and mining and that only 18 percent of that habitat remains.

Adult CV spring-run Chinook salmon enter the Sacramento-San Joaquin Delta (Delta) from the Pacific Ocean beginning in January and enter natal streams from March to July. In Mill Creek, Van Woert (1964) noted that of 18,290 CV spring-run Chinook salmon observed from 1953 to 1963, 93.5 percent were counted between April 1 and July 14, and 89.3 percent were counted between April 29 and June 30.

During their upstream migration, adult Chinook salmon require streamflows sufficient to provide olfactory and other orientation cues used to locate their natal streams. Adequate streamflows also are necessary to allow adult passage to upstream holding habitat. The preferred temperature range for upstream migration is 38 ^{o}F to 56 ^{o}F (Bell 1991, CDFG 1998).

Upon entering fresh water, spring-run Chinook salmon are sexually immature and must hold in cold water for several months to mature. Typically, spring-run Chinook salmon utilize mid- to high-elevation streams that provide appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering. Spring-run Chinook salmon also may utilize tailwaters below dams if cold-water releases provide suitable habitat conditions. Spawning occurs between September and October and, depending on water temperature, emergence occurs between November and February.

CV spring-run Chinook salmon emigration is highly variable (CDFG 1998). Some may begin outmigrating soon after emergence, whereas others oversummer and emigrate as yearlings with the onset of increased fall storms (CDFG 1998). The emigration period for CV spring-run Chinook salmon extends from November to early May, with up to 69 percent of young-of-the-year outmigrants passing through the lower Sacramento River between mid-November and early January (Snider and Titus 2000). Outmigrants also are known to rear in non-natal tributaries to the Sacramento River and the Delta (CDFG 1998).

Chinook salmon spend between 1 and 4 years in the ocean before returning to their natal streams to spawn (Myers *et al.* 1998). Fisher (1994) reported that 87 percent of Chinook salmon trapped and examined at RBDD between 1985 and 1991 were 3-year olds.

Spring-run Chinook salmon were once the most abundant run of salmon in the Central Valley (Campbell and Moyle 1992) and were found in both the Sacramento and San Joaquin drainages. More than 500,000 CV spring-run Chinook salmon were caught in the Sacramento-San Joaquin commercial fishery in 1883 alone (Yoshiyama *et al.* 1998). The San Joaquin populations were essentially extirpated by the 1940s, with only small remnants of the run that persisted through the 1950s in the Merced River (Hallock and Van Woert 1959, Yoshiyama *et al.* 1998). Populations in the upper Sacramento, Feather, and Yuba Rivers were eliminated with the construction of major dams during the1950s and 1960s. Naturally spawning populations of CV spring-run Chinook salmon currently are restricted to accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Mill Creek, Feather River, and the Yuba River (CDFG 1998).

Sacramento River tributary populations in Mill, Deer, and Butte Creeks probably are the best trend indicators for the CV spring-run Chinook ESU as a whole. Table 4 shows the population trends from these tributaries since 1986, including the 5 year moving average and cohort replacement rate. Generally, these streams have shown a positive escapement trend since 1991. Escapement numbers are dominated by Butte Creek returns, including 20,259 in 1998, 9,605 in 2001, 8,785 in 2002, 4,398 in 2003, and 7,390 in 2004 (CDFG 2002, 2003, 2004a). Although recent trends are positive, annual abundance estimates display a high level of fluctuation, and the overall number of CV spring-run Chinook salmon remains well below estimates of historic abundance. Additionally, in 2003, high water temperatures, high fish densities, and an outbreak of Columnaris Disease (*Flexibacter Columnaris*) and Ichthyophthiriasis (*Ichthyophthirius multifiis*) contributed to the pre-spawning mortality of an estimated 11,231 adult spring-run Chinook salmon in Butte Creek. Because the CV spring-run Chinook salmon ESU is confined to relatively few remaining streams continues to display broad fluctuations in abundance and a large proportion of the population (*i.e*., in Butte Creek) faces the risk of high mortality rates, the population is at a moderate to high risk of extinction.

Table 4. Spring-run Chinook salmon population estimates from Mill, Deer, and Butte Creeks since 1986 (CDFG 2004a, CDFG 2004c).

Year	Deer/Mill/Butte Creek Escapement Run Size	5-Year Moving Average of Population Estimate	Cohort Replacement Rate	5-Year Moving Average of Cohort Replacement Rate
1986	2,205	-	-	-
1987	304	-	-	-
1988	2,233	-	-	-
1989	1,947	-	0.29	-
1990	1,590	12,383	0.46	-
1991	798	7,855	0.13	-
1992	1,176	5,629	0.22	-
1993	970	3,490	0.24	0.27

1994	1,682	2,582	1.57	0.52
1995	9,115	3,389	6.35	1.70
1996	2,280	3,604	1.93	2.06
1997	1,301	3,581	0.56	2.13
1998	22,562	8,245	2.52	2.58
1999	5,830	8,950	2.25	2.72
2000	5,299	8,077	3.81	2.21
2001	12,331	10,202	0.54	1.94
2002	12,564	12,559	2.18	2.26
2003	8,583	9,939	1.63	2.08
2004	9,872	10,155	0.74	1.78
2005	14,312	11,926	1.08	1.23

3. Central Valley Steelhead

NMFS listed the Central Valley steelhead (CV steelhead) ESU as threatened on March 19, 1998 (63 FR 13347). The ESU includes all naturally-produced CV steelhead in the Sacramento-San Joaquin River basin. NMFS published a final 4(d) rule for steelhead on July 10, 2000 (65 FR 42422). The 4(d) rule applies the section 9 take prohibitions to threatened species except in cases where the take is associated with State and local programs that are approved by NMFS. In June 2004, NMFS proposed that CV steelhead remain listed as threatened (69 FR 33102). This proposal was based on the recognition that although the NMFS Biological Review Team (BRT) (Good *et al.* 2005) found the ESU "in danger of extinction," ongoing protective efforts for this ESU and the likely implementation of an ESU-wide monitoring program effectively counter this finding. NMFS also is proposing changes involving steelhead hatchery populations (69 FR 31354). The Coleman National Fish Hatchery and FRH steelhead populations are proposed for inclusion in the listed population of steelhead. These populations previously were included in the ESU but were not deemed essential for conservation and thus not part of the listed steelhead population. Finally, NMFS has proposed to include resident *Oncorhynchus mykiss* (rainbow trout), present below natural or long-standing artificial barriers, in all steelhead ESUs (69 FR 33102). The final decisions on these steelhead proposals have been deferred for 6 months for further scientific review (70 FR 37160).

All steelhead stocks in the Central Valley are winter-run steelhead (McEwan and Jackson 1996). Steelhead are similar to Pacific salmon in their life history requirements. They are born in fresh water, emigrate to the ocean, and return to freshwater to spawn. Unlike other Pacific salmon, steelhead are capable of spawning more than once before they die.

The majority of the CV steelhead spawning migration occurs from October through February and spawning occurs from December to April in streams with cool, well oxygenated water that is available year-round. Van Woert (1964) and Harvey (1995) observed that in Mill Creek, the CV steelhead spawning migration is continuous, and although there are two peak periods, 60 percent of the run is passed upstream by December 30.

Incubation time is dependent upon water temperature. Eggs incubate for 1.5 to 4 months before emerging. Eggs held between 50 ^{o}F and 59 ^{o}F hatch within 3 to 4 weeks (Moyle 1976). Fry emerge from redds within in about 4 to 6 weeks depending on redd depth, gravel size, siltation, and temperature (Shapovalov and Taft 1954). Newly emerged fry move to shallow stream margins to escape high water velocities and predation (Barnhart 1986). As fry grow larger they move into riffles and pools and establish feeding locations. Juveniles rear in freshwater for 1 to 4 years (Meehan and Bjornn 1991). Steelhead typically spend 2 years in fresh water. Adults spend to 4 years at sea before returning to freshwater to spawn as 4 or 5 year olds (Moyle 1976).

Steelhead historically were well-distributed throughout the Sacramento and San Joaquin Rivers (Busby *et al.* 1996). Steelhead were found from the upper Sacramento and Pit River systems south to the Kings and possibly the Kern River systems and in both east- and west-side Sacramento River tributaries (Yoshiyama *et al.* 1996). The present distribution has been greatly reduced (McEwan and Jackson 1996). The California Advisory Committee on Salmon and Steelhead (1998) reported a reduction of steelhead habitat from 6,000 miles historically to 300 miles. The California Fish and Wildlife Plan (CDFG 1965) estimated there were 40,000 steelhead in the early 1950s. Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River, upstream of the Feather River.

Nobriga and Cadrett (2003) compared coded wire tagged (CWT) and untagged (wild) steelhead smolt catch ratios at Chipps Island trawl from 1998 to 2001 to estimate that about 100,000 to 300,000 steelhead juveniles are produced naturally each year in the Central Valley. In the *Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead* (Good *et al.* 2005), the BRT made the following conclusion based on the Chipps Island data:

> "If we make the fairly generous assumptions (in the sense of generating large estimates of spawners) that average fecundity is 5,000 eggs per female, 1 percent of eggs survive to reach Chipps Island, and 181,000 smolts are produced (the 1998-2000 average), about 3,628 female steelhead spawn naturally in the entire Central Valley. This can be compared with McEwan's (2001) estimate of 1 million to 2 million spawners before 1850, and 40,000 spawners in the 1960s."

The only consistent data available on wild steelhead numbers in the San Joaquin River basin come from CDFG mid-water trawling samples collected on the lower San Joaquin River at Mossdale. These data indicate a decline in steelhead numbers in the early 1990s, which have remained low through 2002 (CDFG 2003). In 2003, a total of only 12 steelhead smolts were collected at Mossdale (CDFG, unpublished data).

Existing wild steelhead stocks in the Central Valley mostly are confined to upper Sacramento River and its tributaries, including Antelope, Deer, and Mill Creeks, and the Yuba River. Populations may exist in Big Chico and Butte Creeks and a few wild steelhead are produced in the American and Feather Rivers (McEwan and Jackson 1996). Until recently, CV steelhead were thought to be extirpated from the San Joaquin River system. Recent monitoring has detected populations of steelhead in the Stanislaus, Mokelumne, and Calaveras Rivers, and other streams previously thought to be void of steelhead (McEwan 2001). According to the findings of the Interagency Ecological Program Steelhead Project Work Team (IEP SPWT 1999), naturally spawning populations may exist in many other streams but are undetected due to lack of monitoring programs.

Reliable estimates of CV steelhead abundance for different basins are not available (McEwan 2001); however, McEwan and Jackson (1996) estimate the total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults. Steelhead counts at the RBDD have declined from an average of 11,187 for the period of 1967-1977, to an average of approximately 2,000 through the 1990s (McEwan and Jackson 1996, McEwan 2001). The future of CV steelhead is uncertain because of the lack of status and trend data.

4. <u>Southern Distinct Population Segment of North American Green Sturgeon</u>

In North America, spawning populations of the anadromous green sturgeon currently are found in only three river systems, the Sacramento and Klamath Rivers in California and the Rogue River in southern Oregon. Spawning has only been reported in one Asian river, the Tumin River in eastern Asia. Green sturgeon are known to range from Baja California to the Bering Sea along the North American continental shelf. Data from commercial trawl fisheries and tagging studies indicate that the green sturgeon occupy waters within the 110 meter contour (NMFS 2005). During the late summer and early fall, subadults and nonspawning adult green sturgeon frequently can be found aggregating in estuaries along the Pacific coast (Emmett *et al.* 1991). Particularly large concentrations occur in the Columbia River estuary, Willapa Bay, and Grays Harbor, with smaller aggregations in San Francisco and San Pablo Bays (Emmett *et* al 1991, Moyle *et al.* 1992, Beamesderfer *et al.* 2004). Recent acoustical tagging studies on the Rogue River (Erickson *et al*. 2002) have shown that adult green sturgeon will hold for as much as 6 months in deep (> 5m), low gradient reaches or off channel sloughs or coves of the river during summer months when water temperatures were between 15 ^{o}C and 23 ^{o}C. When ambient temperatures in the river dropped in autumn and early winter (< 10 ^{o}C) and flows increased, fish moved downstream and into the ocean.

Adult green sturgeon are believed to feed primarily upon benthic invertebrates such as clams, mysid and grass shrimp, and amphipods (Radtke 1966). Adult sturgeon caught in Washington state waters were found to have fed on Pacific sand lance (*Ammodytes hexapterus*) and callianassid shrimp (Moyle *et al.* 1992).

Adult green sturgeon are believed to spawn every 3 to 5 years and reach sexual maturity only after several years of growth (10 to 15 years based on sympatric white sturgeon sexual maturity). Adult female green sturgeon produce between 60,000 and 140,000 eggs, depending on body size, with a mean egg diameter of 4.3 mm (Moyle *et al.* 1992, Van Eenennaam *et al*. 2001). They have the largest egg size of any sturgeon, and the volume of yolk ensures an ample supply of energy for the developing embryo. The eggs are less adhesive and more dense than than those of white sturgeon (Kynard *et al.* 2005). Green sturgeon adults begin their upstream spawning migrations into freshwater in late February with spawning occuring between March and July. Peak spawning is believed to occur between April and June in deep, turbulent, main channel channels over large cobble and rocky substrates with crevices and interstices. Females broadcast spawn their eggs over this substrate, and the fertilized eggs sink into the interstices of the substrate where they develop further (Kynard *et al.* 2005).

Green sturgeon larvae hatched from fertilized eggs after approximately 169 hours at a water temperature of 15 ^{o}C (Van Eenennaam *et al.* 2001, Deng *et al.* 2002), which is similar to the sympatric white sturgeon development rate (176 hours). Van Eenennaam *et al.* (2005) indicated that an optimum range of water temperature for egg development ranged between 14 ^{o}C and 17 ^{o}C. Temperatures over 23 ^{o}C resulted in 100 percent mortality of fertilized eggs before hatching. Eggs incubated at water temperatures between 17.5 ^{o}C and 22 ^{o}C resulted in elevated mortalities and an increased occurrence of morphological abnormalities in those eggs that did hatch. At incubation temperatures below 14 ^{o}C, hatching mortality also increased significantly, and morphological abnormalities increased slightly, but not statistically so.

Newly hatched green sturgeon are approximately 12.5 to 14.5 mm in length and have a large ovoid yolk sac that supplies nutritional energy until exogenous feeding occurs. The larvae are less developed in their morphology than older juveniles and external morphology resembles a "tadpole" with a continuous fin fold on both the dorsal and ventral sides of the caudal trunk. The eyes are well developed with differentiated lenses and pigmentation. Olfactory and auditory vesicles are present while the mouth and respiratory structures are only shallow clefts on the head. At 10 days of age, the yolk sac has become greatly reduced in size and the larvae initiates exogenous feeding through a functional mouth. The fin folds have become more developed and formation of fin rays begins to occur in all fin tissues. By 45 days of age, the green sturgeon larvae have completed their metamorphosis, which is characterized by the development of dorsal, lateral, and ventral scutes, elongation of the barbels, rostrum, and caudal peduncle, reabsorption of the caudal and ventral fin folds, and the development of fin rays. The juvenile fish resembles the adult form, including the dark olive coloring, with a dark mid-ventral stripe (Deng *et al*. 2002).

Green sturgeon larvae do not exhibit the initial pelagic swim-up behavior characteristic of other A*cipenseridae*. They are strongly oriented to the bottom and exhibit nocturnal activity patterns. After 6 days, the larvae exhibit nocturnal swim-up activity (Deng *et al*. 2002) and nocturnal downstream migrational movements (Kynard *et al.* 2005). Juvenile fish continue to exhibit nocturnal behavioral beyond the metamorphosis from larvae to juvenile stages. Kynard *et al*.'s (2005) laboratory studies indicated that juvenile fish continued to migrate downstream at night for the first 6 months of life. When ambient water temperatures reached 8 ^{o}C, downstream migrational behavior diminished and holding behavior increased. This data suggests that 9 to 10 month old fish would hold over in their natal rivers during the ensuing winter following hatching, but at a location downstream of their spawning grounds.

Green sturgeon juveniles tested under laboratory conditions had optimal bioenergetic performance (*i.e.*, growth, food conversion, swimming ability) between 15 ^{o}C and 19 ^{o}C under either full or reduced rations (Mayfield and Cech 2004). This temperature range overlaps the egg incubation temperature range for peak hatching success previously discussed. Ambient water temperature conditions in the Rogue and Klamath River systems range from 4 ^{o}C to approximately 24 ^{o}C. The Sacramento River has similar temperature profiles, and, like the Rogue and Klamath Rivers, is a regulated system with several dams controlling flows on its main channel (Shasta and Keswick Dams), and its tributaries (Whiskeytown, Oroville, Folsom, and Nimbus Dams).

Larval and juvenile green sturgeon are subject to predation by both native and introduced fish species. Smallmouth bass (*Micropterus dolomieui*) have been recorded on the Rogue River as preying on juvenile green sturgeon, and prickly sculpin (*Cottus asper*) have been shown to be an effective predator on the larvae of sympatric white sturgeon (Gadomski and Parsley 2005). This latter study also indicated that the lowered turbidity found in tailwater streams and rivers due to dams increased the effectiveness of sculpin predation on sturgeon larvae under laboratory conditions.

Based on the distribution of sturgeon eggs, larvae, and juveniles the in the Sacramento River, CDFG (2002) indicated that southern DPS of green sturgeon spawn in late-spring and early-summer above Hamilton City possibly to Keswick Dam. Young green sturgeon appear to rear for the first 1 to 2 months in the Sacramento River between Keswick Dam and Hamilton City (CDFG 2002a). Juvenile green sturgeon first appear in USFWS sampling efforts at RBDD in June and July at lengths ranging in fork length from 24 to 31 mm (CDFG 2002a). Sampling efforts at Glen Colusa Irrigation District on the Sacramento River yield green sturgeons averaging approximately 29 mm in length with a peak abundance occurring in July (NMFS 2002). Since 1980, trawling studies in the San Francisco Bay estuary and Delta have taken a total of 61 juvenile green sturgeon ranging in size from 20 to 112 cm total length and although most juveniles are captured between April and October, they have been captured in nearly every month of the year (CDFG 2002a). Juveniles spend between 1 and 4 years in fresh and estuarine waters and enter the marine environment at lengths of approximately 300 mm (NMFS 2002).

Spawning in the Feather River is suspected to have occurred in the past due to the continued presence of adult green sturgeon in the river below Oroville Dam. This continued presence of adults below the dam suggests that fish are trying to migrate upstream to spawning areas now blocked by the dam which was constructed in 1968. Due to the extreme longevity of green sturgeon (and sturgeon in general), it is possible that these adults represent adults which have previously spawned in the Feather River system prior to the construction of the dam.

Population abundance information concerning the southern DPS of North American green sturgeon is scant as described in the status review (NMFS 2002). Limited population abundance information comes from incidental captures of green sturgeon from the white sturgeon (*Acipenser transmontanus*) monitoring program by the CDFG sturgeon tagging program (CDFG

2002a). CDFG (2002a) utilizes a multiple-census or Peterson mark-recapture method to estimate the legal population of white sturgeon captures in trammel nets. By comparing ratios of white sturgeon to green sturgeon captures, CDFG provides estimates of adult and sub-adult green sturgeon abundance. Estimated abundance between 1954 and 2001 ranged from 175 fish to more than 8,000 per year and averaged 1,509 fish per year. Unfortunately, there are many biases and errors associated with these data, and CDFG does not consider these estimates reliable. Fish monitoring efforts at RBDD and GCID on the upper Sacramento River have captured between 0 and 2,068 juvenile green sturgeon per year, mostly between June and July (NMFS 2002). The only existing information regarding changes in the abundance of the southern DPS of green sturgeon includes changes in their abundance at the John Skinner Fish Protection Facility between 1968 and 2001 (SWP facility). The estimated number of green sturgeon taken at the SWP Facility prior to 1986 was 732; since 1986, the average number has dropped to 47 (70 FR 17386). For the Tracy Fish Collection Facility (CVP facility), the average number prior to 1986 was 889; from 1986 to 2001 the average has dropped to 32 (70 FR 17386). In light of the increased volume of water exports, particularly during the previous 10 years, it is apparent that green sturgeon population abundance is dropping. Catches of sub-adult and adult green sturgeon by the IEP between 1996 and 2004 ranged from 1 to 212 green sturgeon per year (212 occurred in 2001), however, the proportion of the southern DPS of North American green sturgeon is unknown due to the comingling of the Northern and Southern population segments in San Pablo Bay. Additional analysis of green and white sturgeon taken at the SWP and CVP facilities indicates that take of both green and white sturgeon per acre-foot of water exported has decreased substantially since the 1960s (70 FR 17386).

The southern DPS of North American green sturgeon historically was smaller than the sympatric population of white sturgeon in the San Francisco Bay estuary and its associated tributaries. The population has apparently been declining over the past several decades based on harvest numbers from sport and commercial fisheries and the entrainment rates at the CVP and SWP. The principle factor for this decline is the reduction of green sturgeon spawning habitat to a limited area below Keswick Dam on the Sacramento River. The construction of impassable barriers, particularly large dams, has greatly reduced the access of green sturgeon to their historical spawning areas. Reduced flows have corresponded with weakened year class recruitment in the sympatric white sturgeon population and it is believed to have the same effect upon green sturgeon recruitment. In addition to the adverse effects of impassable barriers, numerous agricultural water diversions exist in the Sacramento River and the Delta along the migratory route of larval and juvenile sturgeon. Entrainment, or, if equipped with a fish screen, impingement are considered serious threats to sturgeon during their downstream migration. Fish screens have not been designed with criteria that address sturgeon behavior or swimming capabilities. The benthic oriented sturgeon are also more susceptible to contaminated sediments through dermal contact and through their feeding behavior of ingesting prey along with contaminated sediments before winnowing out the sediment. Their long life spans allow them to accumulate high body burdens of contaminants, that potentially will reach concentrations with deleterious physiological effects. All of the above threats have been identified by the BRT as potentially affecting the continued existence of the southern DPS of North American green strurgeon (70 FR 17386).

B. Critical Habitat Condition and Function for Species' Conservation

Critical habitat for winter-run Chinook salmon was designated on June 16, 1993, and includes the Sacramento River from Keswick Dam (RM 302) downstream to Chipps Island (RM 0) at the westward margin of the Delta; all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of the San Francisco Bay (north of the San Francisco Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. The critical habitat designation identifies those physical and biological features of the habitat that are essential to the conservation of the species and that may require special management consideration or protection. Within the Sacramento River this includes the river water, river bottom (including those areas and associated gravel used by winter-run Chinook salmon as spawning substrate), and adjacent riparian zone used by fry and juveniles for rearing.

Critical habitat for CV spring-run Chinook salmon and CV steelhead was designated on September 2, 2005 (70 FR 52488). Critical habitat includes stream channels within certain occupied stream reaches and includes a lateral extent as defined by the ordinary high water mark (33 CFR 329.11) or the bankfull elevation. Critical habitat in estuarine reaches is defined by the perimeter of the water body or the elevation of the extreme high water mark, whichever is greater. The primary constituent elements (PCEs) of critical habitat include freshwater spawning sites, freshwater rearing areas, freshwater migration corridors, and estuarine areas. The reach of the Sacramento River that contains the action area is designated critical habitat for SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead.

The freshwater habitat of salmon, steelhead, and sturgeon in the Sacramento River, San Joaquin River, and Suisun Marsh watershed drainages varies in function depending on location. Spawning areas are located in accessible, upstream reaches of the Sacramento or San Joaquin Rivers and their watersheds where viable spawning gravels and water quality are found. Freshwater spawning sites are PCEs of critical habitat for salmonids. The condition of spawning habitat is greatly affected by factors such as water temperature, DO, and silt load, which can greatly affect the survival of eggs and larvae. High quality spawning habitat is now inaccessible behind large dams in these watersheds, which limits salmonids to spawning in marginal tailwater habitat below the dams. Despite often intensive management efforts, the existing spawning habitat below dams is highly susceptible to inadequate flows and high temperatures due to competing demands for water, which impairs the habitat function.

Freshwater migration corridors and estuarine areas also are PCEs of critical habitat. They are located downstream of spawning habitat and include the Delta and Suisun Marsh. These areas allow the upstream passage of adults and the downstream emigration of juveniles. Migratory habitat conditions are impaired in each of these drainages by the presence of barriers, which can include dams, unscreened or poorly-screened diversions, inadequate water flows, and degraded water quality.

Freshwater rearing sites for juveniles, which feed and grow before and during their outmigration, are PCEs of critical habitat. Non-natal, intermittent tributaries also may be used for juvenile rearing by salmonids, but such use has not been documented for sturgeon. Rearing habitat condition is strongly affected by factors such as water quantity and quality, and the availability of natural cover and food, which allow juveniles to grow and avoid predators. Some complex, productive habitats with floodplains remain in the Sacramento and San Joaquin River systems (*e.g.*, the lower Cosumnes River, Sacramento River reaches with setback levees (*i.e.*, primarily located upstream of the City of Colusa) and the Yolo and Sutter bypasses). However, the channelized, leveed, and riprapped river reaches and sloughs that are common in the Delta and Suisun Marsh systems typically have low food abundance and low cover availability, and offer little protection from either fish or avian predators.

C. Factors Affecting the Species and Habitat

A number of documents have addressed the history of human activities, present environmental conditions, and factors contributing to the decline of salmon and steelhead species in the Central Valley. For example, NMFS prepared range-wide status reviews for west coast Chinook salmon (Myers *et al.* 1998) and steelhead (Busby *et al.* 1996). Also, the NMFS BRT published an updated status review for west coast Chinook salmon and steelhead in June 2005 (Good *et al.* 2005). Information also is available in Federal Register notices announcing ESA listing proposals and determinations for some of these species and their critical habitat (*e.g.*, 58 FR 33212, 59 FR 440, 62 FR 24588, 62 FR 43937, 63 FR 13347, 64 FR 24049, 64 FR 50394, 65 FR 7764). The Final Programmatic Environmental Impact Statement/Report (EIS/EIR) for the CALFED Bay-Delta Program (CBDA 1999) and the Department of the Interior's (DOI) Final Programmatic EIS for the Central Valley Project Improvement Act (CVPIA) (DOI 1999) provide summaries of historical and recent environmental conditions for salmon and steelhead in the Central Valley. The following general description of the factors affecting the viability of SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead is based on a summarization of these documents.

In general, the human activities that have affected listed anadromous salmonids, North American green sturgeon, or their habitats consist of: (1) dam construction that blocks previously accessible habitat; (2) water development and management activities that affect water quantity, flow timing, and quality; (3) land use activities such as agriculture, flood control, urban development, mining, road construction, and logging that degrade aquatic and riparian habitat; 4) hatchery operation and practices; (5) harvest activities; (6) predation; and (7) ecosystem restoration actions.

1. Habitat Blockage

Hydropower, flood control, and water supply dams of the Central Valley Project (CVP), State Water Project (SWP), and other municipal and private entities have permanently blocked or hindered salmonid access to historical spawning and rearing grounds. Clark (1929) estimated that originally there were 6,000 miles of salmon habitat in the Central Valley system and that 80 percent of this habitat had been lost by 1928. Yoshiyama *et al.* (1996) calculated that roughly 2,000 miles of salmon habitat was actually available before dam construction and mining, and concluded that 82 percent is not accessible today.

In general, large dams on every major tributary to the Sacramento River, San Joaquin River, and the Delta block salmon and steelhead access to the upper portions of the respective watersheds. On the Sacramento River, Keswick Dam blocks passage to historic spawning and rearing habitat in the upper Sacramento, McCloud, and Pit Rivers. Whiskeytown Dam blocks access to the upper watershed of Clear Creek. Oroville Dam and associated facilities block passage to the upper Feather River watershed. Nimbus Dam blocks access to most of the American River basin. Friant Dam construction in the mid-1940s has been associated with the elimination of spring-run Chinook salmon in the San Joaquin River upstream of the Merced River (DOI 1999). On the Stanislaus River, construction of New Melones Dam and Goodwin Dam blocked both spring and fall-run Chinook salmon (CDFG 2001).

As a result of the dams, SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead populations on these rivers have been confined to lower elevation main channels that historically only were used for migration. Population abundances have declined in these streams due to decreased quantity and quality of spawning and rearing habitat. Higher temperatures at these lower elevations during late-summer and fall are a major stressor to adult and juvenile salmonids.

The Suisun Marsh Salinity Control Gates (SMSCG), located on Montezuma Slough, were installed in 1988, and are operated with gates and flashboards to decrease the salinity levels of managed wetlands in Suisun Marsh. The SMSCG have delayed or blocked passage of adult Chinook salmon migrating upstream (Edwards *et al.* 1996, Tillman *et al.* 1996).

2. Water Development

The diversion and storage of natural flows by dams and diversion structures on Central Valley waterways have depleted stream flows and altered the natural cycles by which juvenile and adult salmonids base their migrations. Depleted flows have contributed to higher temperatures, lower dissolved oxygen levels, and decreased recruitment of gravel and large woody debris (LWD). Furthermore, more uniform year-round flows have resulted in diminished natural channel formation, altered foodweb processes, and slower regeneration of riparian vegetation. These stable flow patterns have reduced bedload movement (Ayers 2001), caused spawning gravels to become embedded and reduced channel width, which has decreased the available spawning and rearing habitat below dams.

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found throughout the Central Valley. Hundreds of small and medium-size water diversions exist along the Sacramento River, San Joaquin River, and their tributaries. Although efforts have been made in recent years to screen some of these diversions, many remain unscreened. Depending on the size, location, and season of operation, these unscreened intakes entrain and kill many life stages of aquatic species, including juvenile salmonids. For example, as of 1997, 98.5 percent of the 3,356 diversions included in a Central Valley database were either unscreened or screened insufficiently to prevent fish entrainment (Herren and Kawasaki 2001). Most of the 370 water diversions operating in Suisun Marsh are unscreened (USFWS 2003).

Outmigrant juvenile salmonids in the Delta have been subjected to adverse environmental conditions created by water export operations at the CVP/SWP. Specifically, juvenile salmonid survival has been reduced from: (1) water diversion from the main channel Sacramento River into the Central Delta via the Delta Cross Channel; (2) upstream or reverse flows of water in the lower San Joaquin River and southern Delta waterways; (3) entrainment at the CVP/SWP export facilities and associated problems at Clifton Court Forebay; and (4) increased exposure to introduced, non-native predators such as striped bass (*Morone saxatilis*), largemouth bass (*Micropterus salmoides*), and American shad (*Alosa sapidissima*).

The consultation for the CVP operations, criteria, and plan (OCAP) was completed with the issuance of a biological opinion by NMFS on October 22, 2004. The OCAP biological opinion found that CVP and SWP actions are likely to adversely affect Federally listed SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead, and the critical habitat of winter-run Chinook salmon, due to reservoir releases, Sacramento River flows, water temperatures, and physical facility operations that reduce habitat availability and suitability. These effects are expected to impact and result in the take of individual fish by delaying or blocking adult migration into suitable spawning habitat and decreasing spawning success, killing vulnerable life stages such as eggs, larvae, and juveniles due to stranding or elevated water temperatures, or increasing the likelihood of disease or juvenile vulnerability to predation due to temperature stress. NMFS determined that these effects are not likely to jeopardize the continued existence of SR winter-run Chinook salmon, CV spring-run Chinook salmon, or CV steelhead, and are not likely to destroy or adversely modify their designated critical habitat.

3. <u>Land Use Activities</u>

Land use activities continue to have large impacts on salmonid habitat in the Central Valley. Until about 150 years ago, the Sacramento River was bordered by up to 500,000 acres of riparian forest, with bands of vegetation extending outward for 4 or 5 miles (California Resources Agency 1989). By 1979, riparian habitat along the Sacramento River had diminished to 11,000 to 12,000 acres, or about 2 percent of historic levels (McGill 1987). The degradation and fragmentation of riparian habitat had resulted mainly from flood control and bank protection projects, together with the conversion of riparian land to agriculture (Jones and Stokes Associates, Incorporated 1993).

Increased sedimentation resulting from agricultural and urban practices within the Central Valley is a primary cause of salmonid habitat degradation (NMFS 1996). Sedimentation can adversely affect salmonids during all freshwater life stages by: clogging or abrading gill surfaces, adhering to eggs, and restricting fry emergence (Phillips and Campbell 1961); burying eggs or alevins; scouring and filling in pools and riffles; reducing primary productivity and photosynthesis activity (Cordone and Kelley 1961); and affecting intergravel permeability and dissolved oxygen levels. Excessive sedimentation over time can cause substrates to become embedded, which reduces successful salmonid spawning, and egg and fry survival (Hartmann *et al.* 1987).

Land use activities associated with road construction, urban development, logging, mining, agriculture, and recreation have significantly altered fish habitat quantity and quality through alteration of streambank and channel morphology, alteration of ambient water temperatures, degradation of water quality, elimination of spawning and rearing habitat, fragmentation of available habitats, elimination of downstream recruitment of LWD, and removal of riparian vegetation resulting in increased streambank erosion (Meehan and Bjornn 1991). Agricultural practices in the Central Valley have eliminated large trees and logs and other woody debris that would otherwise be recruited into the stream channel (NMFS 1998). LWD influences stream morphology by affecting channel pattern, position, and geometry, as well as pool formation (Keller and Swanson 1979, Bilby 1984, Robison and Beschta 1990).

Since the 1850s, wetlands reclamation for urban and agricultural development has caused the cumulative loss of 79 and 94 percent of the tidal marsh habitat in the Delta downstream and upstream of Chipp's Island, respectively (Goals Project 1999). In Suisun Marsh, salt water intrusion and land subsidence gradually have led to the decline of agricultural production. Presently, Suisun Marsh consists largely of tidal sloughs and managed wetlands for duck clubs.

Juvenile salmonids are exposed to increased water temperatures in the Delta during the late spring and summer due to the loss of riparian shading, and by thermal inputs from municipal, industrial, and agricultural discharges. Studies by CDWR on water quality in the Delta over the last 30 years show a steady decline in the food sources available for juvenile salmonids and an increase in the clarity of the water. These conditions likely have contributed to increased mortality of juvenile Chinook salmon and steelhead as they move through the Delta.

4. Hatchery Operations and Practices

Five hatcheries currently produce Chinook salmon in the Central Valley and four of these also produce steelhead. Releasing large numbers of hatchery fish can pose a threat to wild Chinook salmon and steelhead stocks through genetic impacts, competition for food and other resources between hatchery and wild fish, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production (Waples 1991). The genetic impacts of artificial propagation programs in the Central Valley primarily are caused by straying of hatchery fish and the subsequent interbreeding of hatchery fish with wild fish. In the Central Valley, practices such as transferring eggs between hatcheries and trucking smolts to distant sites for release contribute to elevated straying levels (DOI 1999). For example, Nimbus Hatchery on the American River rears Eel River steelhead stock and releases these fish in the Sacramento River.

Hatchery practices as well as spatial and temporal overlaps of habitat use and spawning activity between spring- and fall-run fish have led to the hybridization and homogenization of some subpopulations (CDFG 1998). As early as the 1960s, Slater (1963) observed that early fall- and spring-run Chinook salmon were competing for spawning sites in the Sacramento River below Keswick Dam, and speculated that the two runs may have hybridized. FRH spring-run Chinook salmon have been documented as straying throughout the Central Valley for many years (CDFG 1998). Although the degree of hybridization has not been comprehensively determined, it is clear that the populations of spring-run Chinook salmon spawning in the Feather River and counted at RBDD contain hybridized fish.

The management of hatcheries, such as Nimbus Hatchery and FRH, can directly impact CV spring-run Chinook salmon and CV steelhead populations by overproducing the natural capacity of the limited habitat available below dams. In the case of the Feather River, significant redd superimposition occurs in-river due to hatchery overproduction and the inability to physically separate CV spring- and fall-run Chinook salmon adults. This concurrent spawning has led to hybridization between the spring- and fall-run Chinook salmon in the Feather River. At Nimbus Hatchery, operating Folsom Dam to meet temperature requirements for returning hatchery fall-run Chinook salmon often limits the amount of water available for steelhead spawning and rearing the rest of the year.

The increase in Central Valley hatchery production has reversed the composition of the steelhead population, from 88 percent naturally-produced fish in the 1950s (McEwan 2001) to an estimated 23 to 37 percent naturally-produced fish currently (Nobriga and Cadrett 2003). The increase in hatchery steelhead production proportionate to the wild population has reduced the viability of the wild steelhead populations, increased the use of out-of-basin stocks for hatchery production, and increased straying (NMFS 2001). Thus, the ability of natural populations to successfully reproduce has likely been diminished.

The relatively low number of spawners needed to sustain a hatchery population can result in high harvest-to-escapement ratios in waters where regulations are set according to hatchery population. This can lead to over-exploitation and reduction in size of wild populations coexisting in the same system (McEwan 2001).

Hatcheries also can have some positive effects on salmonid populations. Artificial propagation has been shown effective in bolstering the numbers of naturally spawning fish in the short term under certain conditions, and in conserving genetic resources and guarding against catastrophic loss of naturally spawned populations at critically low abundance levels, such as SR winter-run Chinook salmon. However, relative abundance is only one component of a viable salmonid population.

5. <u>Ocean and Sport Harvest</u>

Extensive ocean recreational and commercial troll fisheries for Chinook salmon exist along the Central California coast, and an inland recreational fishery exists in the Central Valley for Chinook salmon and steelhead. Ocean harvest of Central Valley Chinook salmon is estimated using an abundance index, called the Central Valley Index (CVI). The CVI is the ratio of

Chinook salmon harvested south of Point Arena (where 85 percent of Central Valley Chinook salmon are caught) to escapement. CWT returns indicate that Sacramento River salmon congregate off the coast between Point Arena and Morro Bay.

Historically in California, almost half of the river sportfishing effort was in the Sacramento-San Joaquin River system, particularly upstream from the city of Sacramento (Emmett *et al.* 1991). Since 1987, the Fish and Game Commission has adopted increasingly stringent regulations to reduce and virtually eliminate the in-river sport fishery for winter-run Chinook salmon. Present regulations include a year-round closure to Chinook salmon fishing between Keswick Dam and the Deschutes Road Bridge and a rolling closure to Chinook salmon fishing on the Sacramento River between the Deschutes River Bridge and the Carquinez Bridge. The rolling closure spans the months that migrating adult winter-run Chinook salmon are ascending the Sacramento River to their spawning grounds. These closures have virtually eliminated impacts on winter-run Chinook salmon caused by recreational angling in freshwater. In 1992, the California Fish and Game Commission adopted gear restrictions (all hooks must be barbless and a maximum of 5.7 cm in length) to minimize hooking injury and mortality of winter-run Chinook salmon caused by trout anglers.

In-river recreational fisheries historically have taken CV spring-run Chinook salmon throughout the species' range. During the summer, holding adult CV spring-run Chinook salmon are easily targeted by anglers when they congregate in large pools. Poaching also occurs at fish ladders, and other areas where adults congregate; however, the significance of poaching on the adult population is unknown. Specific regulations for the protection of CV spring-run Chinook salmon in Mill, Deer, Butte and Big Chico Creeks were added to the existing CDFG regulations in 1994. The current regulations, including those developed for winter-run Chinook salmon, provide some level of protection for CV spring-run Chinook salmon (CDFG 1998).

There is little information on steelhead harvest rates in California. Hallock *et al.* (1961) estimated that harvest rates for Sacramento River steelhead from the 1953-1954 through 1958-1959 seasons ranged from 25.1 percent to 45.6 percent assuming a 20 percent non-return rate of tags. Staley (1975) estimated the harvest rate in the American River during the 1971-1972 and 1973-1974 seasons to be 27 percent. The average annual harvest rate of adult steelhead above RBDD for the three-year period from 1991-1992 through 1993-1994 was 16 percent (McEwan and Jackson 1996). Since 1998, all hatchery steelhead have been marked with an adipose fin clip allowing anglers to distinguish hatchery and wild steelhead. Current regulations restrict anglers from keeping unmarked steelhead in Central Valley streams (CDFG 2004b). Overall, this regulation has greatly increased protection of naturally produced adult CV steelhead.

Green sturgeon are caught incidentally by sport fisherman targeting the more highly desired white sturgeon within the Delta waterways and the Sacramento River. Due to slot limits imposed on the sport fishery by the California DFG, only sturgeon between 46 and 72 inches may be retained by sport fisherman with a daily bag limit of 1 fish in possession. This protects both fish that are sexually immature and have not yet had an opportunity to spawn, and those larger females that have the greatest reproductive value to the population.

6. Predation

Accelerated predation also may be a factor in the decline of winter-run Chinook salmon and CV spring-run Chinook salmon, and to a lesser degree CV steelhead. Additionally, human-induced habitat changes such alteration of natural flow regimes and installation of bank revetment and structures such as dams, bridges, water diversions, piers, and wharves often provide conditions that both disorient juvenile salmonids and attract predators (Stevens 1961, Decato 1978, Vogel *et al.* 1988, Garcia 1989).

On the main channel Sacramento River, high rates of predation are known to occur at RBDD, Anderson Cottonwood Irrigation District, Glenn Colusa Irrigation District, areas where rock revetment has replaced natural river bank vegetation, and at south Delta water diversion structures (*e.g.*, Clifton Court Forebay; CDFG 1998). Predation at RBDD on juvenile winter-run Chinook salmon is believed to be higher than normal due to factors such as water quality and flow dynamics associated with the operation of this structure. Due to their small size, early emigrating winter-run Chinook salmon may be very susceptible to predation in Lake Red Bluff when the RBDD gates remain closed in summer and early fall (Vogel *et al.* 1988). In passing the dam, juveniles are subject to conditions which severely disorient them, making them highly susceptible to predation by fish or birds. Sacramento pikeminnow (*Ptychocheilus grandis*) and striped bass congregate below the dam and prey on juvenile salmon.

USFWS found that more predatory fish were found at rock revetment bank protection sites between Chico Landing and Red Bluff than at sites with naturally eroding banks (Michny and Hampton 1984). From October 1976 to November 1993, CDFG conducted ten mark/recapture experiments at the SWP's Clifton Court Forebay to estimate pre-screen losses using hatchery-reared juvenile Chinook salmon. Pre-screen losses ranged from 69 percent to 99 percent. Predation from striped bass is thought to be the primary cause of the loss (Gingras 1997).

Other locations in the Central Valley where predation is of concern include flood bypasses, release sites for salmonids salvaged at the State and Federal fish facilities, and the SMSCG. Predation on salmon by striped bass and pikeminnow at salvage release sites in the Delta and lower Sacramento River has been documented (Orsi 1967, Pickard *et al.* 1982). Predation rates at these sites are difficult to determine. CDFG conducted predation studies from 1987-1993 at the SMSCG to determine if the structure attracts and concentrates predators. The dominant predator species at the structure was striped bass, and juvenile Chinook salmon were identified in their stomach contents (NMFS 1997).

7. Environmental Variation

Natural changes in the freshwater and marine environments play a major role in salmonid abundance. Recent evidence suggests that marine survival among salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity (Hare *et al*. 1999, Mantua and Hare 2002). This phenomenon has been referred to as the Pacific Decadal

Oscillation. In addition, large-scale climatic regime shifts, such as the El Niño condition, appear to change productivity levels over large expanses of the Pacific Ocean. A further confounding effect is the fluctuation between drought and wet conditions in the basins of the American west. During the first part of the 1990s, much of the Pacific Coast was subject to a series of very dry years, which reduced inflows to watersheds up and down the west coast.

A key factor affecting many West Coast stocks has been a general 30-year decline in ocean productivity. The mechanism whereby stocks are affected is not well understood, partially because the pattern of response to these changing ocean conditions has differed among stocks, presumably due to differences in their ocean timing and distribution. It is presumed that survival in the ocean is driven largely by events occurring between ocean entry and recruitment to a subadult life stage.

Salmon and steelhead are exposed to high rates of natural predation, particularly during freshwater rearing and migration stages. Predation rates on juvenile and adult green sturgeon have not been adequately studied to date. Ocean predation may also contribute to significant natural mortality, although it is not known to what extent. In general, salmonids are prey for pelagic fishes, birds, and marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns that the rebound of seal and sea lion populations following their protection under the Marine Mammal Protection Act of 1972 has increased the number of salmonid deaths.

Unusual drought conditions may warrant additional consideration in California. Flows in 2001 were among the lowest flow conditions on record in the Central Valley. The available water in the Sacramento watershed and San Joaquin watershed was 70 percent and 66 percent of normal, according to the Sacramento River Index and the San Joaquin River Index, respectively. Back-to-back drought years could be catastrophic to small populations of listed salmonids that are dependent upon reservoir releases for their success (*e.g*., winter-run Chinook salmon). Therefore, reservoir carryover storage (usually referred to as end-of-September storage) is a key element in providing adequate reserves to protect salmon and steelhead during extended drought periods. In order to buffer the effect of drought conditions and over allocation of resources, NMFS in the past has recommended that minimum carryover storage be maintained in Shasta and other reservoirs to help alleviate critical flow and temperature conditions in the fall. Green sturgeon's need for appropriate water temperatures would also benefit from river operations that maintain a suitable temperature profile for this species.

The future effects of global warming are of key interest to salmonid and green sturgeon survival. It is predicted that Sierra snow packs will dwindle with global warming and that the majority of runoff in California will be from rainfall in the winter rather than from melting snow pack in the mountains. This will alter river runoff patterns and transform the tributaries that feed the Central Valley from a spring/summer snowmelt dominated system to a winter rain dominated system. It can be rationally hypothesized that summer temperatures and flow levels will become unsuitable for salmonid survival. The cold snowmelt that furnishes the late spring and early summer runoff will be replaced by warmer precipitation runoff. This should truncate the period of time that suitable cold-water conditions exist below existing reservoirs and dams due to the warmer inflow temperatures to the reservoir from rain runoff. Without the necessary cold water pool developed from melting snow pack filling reservoirs in the spring and early summer, late summer and fall temperatures below reservoirs, such as Lake Shasta, could potentially rise above thermal tolerances for juvenile and adult salmonids (*i.e.*, SR winter-run Chinook salmon and CV steelhead) that must hold below the dam over the summer and fall periods. Similar, although potentially to a lesser degree, declines in green sturgeon populations are anticipated with reduced cold-water flows. Green sturgeon egg and larval development are optimized at water temperatures that are only slightly higher than those for salmonids. Lethal temperatures are similar to salmonids, although slightly higher than those for salmonids.

8. <u>Ecosystem Restoration</u>

a. *CALFED Bay-Delta Authority*

Two programs under CBDA, the Environmental Restoration Program (ERP) and the Environmental Water Account (EWA), were created to improve conditions for fish, including listed salmonids, in the Central Valley. Restoration actions implemented by the ERP include the installation of fish screens, modification of barriers to improve fish passage, habitat acquisition, and instream habitat restoration. The majority of these recent actions address key factors affecting listed salmonids, and emphasis has been placed in tributary drainages with high potential for CV steelhead and CV spring-run Chinook salmon production. Additional ongoing actions include new efforts to enhance fisheries monitoring and directly support salmonid production through hatchery releases. Recent habitat restoration initiatives sponsored and funded primarily by the CBDA-ERP program have resulted in plans to restore ecological function to 9,543 acres of shallow-water tidal and marsh habitats within the Delta. Restoration of these areas primarily involves flooding lands previously used for agriculture, thereby creating additional rearing habitat for juvenile salmonids. Similar habitat restoration is imminent adjacent to Suisun Marsh (*i.e.*, at the confluence of Montezuma Slough and the Sacramento River) as part of the Montezuma Wetlands project, which is intended to provide for commercial disposal of material dredged from San Francisco Bay in conjunction with tidal wetland restoration.

A sub-program of the ERP called the Environmental Water Program has been established to support ERP projects through enhancement of instream flows that are biologically and ecologically significant. This program is in the development stage and the benefits to listed salmonids are not yet clear. Clear Creek is one of five watersheds in the Central Valley that has been targeted for action during Phase I of this program.

The EWA is geared to providing water at critical times to meet ESA requirements and incidental take limits without water supply impacts to other users. In early 2001, EWA released 290,000 acre-feet of water at key times to offset reductions in south Delta pumping to protect winter-run Chinook salmon and other Delta fish species. The actual number of fish saved was very small.

The anticipated benefits to fisheries from EWA were much higher than what has actually occurred.

b. *Central Valley Project Improvement Act*

The CVPIA, implemented in 1992, requires that fish and wildlife get equal consideration with water allocations from the CVP. From this act arose two programs that benefit listed salmonids: the Anadromous Fish Restoration Program (AFRP) and the Water Acquisition Program (WAP). The AFRP has engaged in monitoring, education, and restoration projects geared toward recovery of all anadromous fish species residing in the Central Valley. Restoration projects funded through the AFRP include fish passage, fish screening, riparian easement and land acquisition, development of watershed planning groups, instream and riparian habitat improvement, and gravel replenishment. The goal of the WAP is to acquire water supplies to meet the habitat restoration and enhancement goals of the CVPIA and to improve the DOI's ability to meet regulatory water quality requirements. Water has been used successfully to improve fish habitat for CV spring-run Chinook salmon and CV steelhead by maintaining or increasing instream flows in Butte and Mill Creeks and the San Joaquin River at critical times.

c. *Iron Mountain Mine Remediation*

The Environmental Protection Agency's Iron Mountain Mine remediation involves the removal of toxic metals in acidic mine drainage from the Spring Creek Watershed with a state-of-the-art lime neutralization plant. Contaminant loading into the Sacramento River from Iron Mountain Mine has shown measurable reductions since the early 1990s. Decreasing the heavy metal contaminants that enter the Sacramento River should increase the survival of salmonid eggs and juveniles. However, during periods of heavy rainfall upstream of the Iron Mountain Mine, the Bureau of Reclamation (BOR) substantially increases Sacramento River flows in order to dilute heavy metal contaminants being spilled from Spring Creek debris dam. This rapid change in flows can cause juvenile salmonids to become stranded or isolated in side channels below Keswick Dam.

d. *State Water Project Delta Pumping Plant Fish Protection Agreement (Four-Pumps Agreement)*

The Four-Pumps Agreement Program has approved about $49 million for projects that benefit salmon and steelhead production in the Sacramento-San Joaquin basins and Delta since the agreement inception in 1986. Four Pumps projects that benefit CV spring-run Chinook salmon and CV steelhead include water exchange programs on Mill and Deer Creeks; enhanced law enforcement efforts from San Francisco Bay upstream to the Sacramento and San Joaquin Rivers and their tributaries; design and construction of fish screens and ladders on Butte Creek; and screening of diversions in Suisun Marsh and San Joaquin tributaries. Other Four-Pumps projects, predator habitat isolation and removal, and spawning habitat enhancement projects on the San Joaquin tributaries, benefit CV steelhead.

The Spring-run Salmon Increased Protection project provides overtime wages for CDFG wardens to focus on reducing illegal take and illegal water diversions on upper Sacramento River tributaries and adult holding areas, where the fish are vulnerable to poaching. This project covers Mill, Deer, Antelope, Butte, Big Chico, Cottonwood, and Battle Creeks, and has been in effect since 1996. Through the Delta-Bay Enhanced Enforcement Program, initiated in 1994, a team of 10 wardens focus their enforcement efforts on salmon, steelhead, and other species of concern from the San Francisco Bay Estuary upstream into the Sacramento and San Joaquin River basins. These two enhanced enforcement programs, in combination with additional concern and attention from local landowners and watershed groups on the Sacramento River tributaries which support CV spring-run Chinook salmon summer holding habitat, have been shown to reduce the amount of poaching in these upstream areas.

The provisions of funds to cover over-budget costs for the Durham Mutual/Parrot Phelan Screen and Ladders project expedited completion of the construction phase of this project which was completed during 1996. The project continues to benefit salmon and steelhead by facilitating upstream passage of adult spawners and downstream passage of juveniles.

The Mill and Deer Creek Water Exchange projects are designed to provide new wells that enable diverters to bank groundwater in place of stream flow, thus leaving water in the stream during critical migration periods. On Mill Creek several agreements between Los Molinos Mutual Water Company (LMMWC), Orange Cove Irrigation District (OCID), CDFG, and CDWR allows CDWR to pump groundwater from two wells into the LMMWC canals to pay back LMMWC water rights for surface water released downstream for fish. Although the Mill Creek Water Exchange project was initiated in 1990 and the agreement was for a well capacity of 25 cfs, only 12 cfs has been developed to date (BOR and OCID 1999). In addition, it has been determined that a base flow of greater than 25 cfs is needed during the April through June period for upstream passage of adult CV spring-run Chinook salmon in Mill Creek (BOR and OCID 1999). In some years, water diversions from the creek are curtailed by amounts sufficient to provide for passage of upstream migrating adult CV spring-run Chinook salmon and downstream migrating juvenile CV steelhead and CV spring-run Chinook salmon. However, the current arrangement does not ensure adequate flow conditions will be maintained in all years. CDWR, CDFG, and USFWS have developed the Mill Creek Adaptive Management Enhancement Plan to address the instream flow issues. A pilot project using one of the 10 pumps originally proposed for Deer Creek was tested in summer 2003. Future testing is planned with implementation to follow.

IV. ENVIRONMENTAL BASELINE

The environmental baseline is an analysis of the effects of past and ongoing human and natural factors leading to the status of the species within the action area. The environmental baseline "includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process" (50 CFR §402.02).

A. Status of the Species and Habitat in the Action Area

The action area below CM 18.6 of the SDWSC lies within designated critical habitat of the SR winter-run Chinook salmon, CV spring-run Chinook salmon and CV steelhead. This section of the SDWSC is within a reach of the main channel Sacramento River that is confined by levees, protected by rock riprap, and lined with sparse amounts of shaded riverine aquatic (SRA) cover. The primary constituent elements of critical habitat in the action area are freshwater rearing sites and migration corridors, and estuarine habitat.

1. Status of the Species within the Action Area

The action area below CM 18.6 of the SDWSC functions as a migratory corridor for adult SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead, and provides migration and rearing habitat for juveniles of these species. A large proportion of all Federally listed Central Valley salmonids are expected to utilize aquatic habitat within the action area. The action area above this point is an artificial channel with no fish passage at its terminus. The average ship traffic in the SDWSC is one vessel per week.

The numbers of salmon and steelhead that enter the upper section of the SDWSC and follow it upstream to the lock is unknown. However, existing information indicates that adult Chinook salmon and steelhead migrate into the action area and their upstream passage is blocked by the locks. Fisheries investigations conducted by the FWS in the upper section of the SDWSC from May 1994 to November 1994, using gill nets, otter trawls, and angler surveys, found that adult Chinook salmon are present behind the lock throughout the summer and fall months, and are likely to be present year-round (FWS 1995). The only other known fish sampling efforts in the SDWSC were conducted on an intermittent basis by DFG using gill nets, otter trawls, and angler surveys (Corps 1995). These efforts recorded two Chinook salmon and one steelhead in 1973, one steelhead in 1974, five Chinook salmon and two steelhead in 1975, one Chinook salmon in 1976, and ten Chinook salmon in 1993. In 1994, 90 fall-run Chinook salmon were radio-tagged and released in the Suisun Bay as part of an IEP migration study; one of these fish was subsequently detected in the upper SDWSC. Juvenile Chinook salmon and steelhead outmigrate past the upstream entrance (lock) to the SDWSC from late fall to spring.

With the locks closed, leaks in the lock seals contribute some fresh water to the channel and are thought to be creating a small attraction flow (<1 cfs) for adult Chinook salmon and steelhead. Prior to the reduced operation of the lock, flow diversions through the SDWSC probably created a greater attraction to adult salmon and steelhead, which may have successfully continued their upstream migration through the channel and into the Sacramento River when the lock gates were opened. Although discontinued use of the lock has probably reduced the attraction of salmonids to the upper SDWSC, a limited, yet unknown number of fish, currently enter the upper section of the SDWSC and are observed staging below the locks (DWR 2002). The status of green sturgeon in the upper section of the SDWSC is unknown; however, more abundant white sturgeon (*Acipenser transmontanus*) have been captured in the Yolo Bypass toe drain, which is accessed from Cache Slough and is adjacent to the upper section of the SDWSC (Harrell and Sommer 2003).

a. *Sacramento River winter-run Chinook Salmon*

SR winter-run Chinook salmon currently are present only in the Sacramento River below Keswick Dam, and are composed of a single breeding population (NMFS 1997; see *III. Status of the Species and Critical Habitat*). The entire population of adults and juveniles migrate through the lower Sacramento River and must pass through the portion of the action area located within the mainstem Sacramento River.

The migration timing of listed salmon and steelhead in the action area can be approximated by assessing studies that examine run timing in the Sacramento River (*e.g.*, Hallock *et al.* 1957, Van Woert 1958, Vogel and Marine 1991, Snider and Titus 2000). Adults enter San Francisco Bay from November through June (Van Woert 1958), and migrate up the Sacramento River from December through early August (Vogel and Marine 1991). Juvenile Chinook salmon emigrate through the action area from late fall to spring. Snider and Titus (2000) observed that juvenile salmon emigrate through the lower Sacramento River, at Knights Landing, in three phases. The first phase is the initiation of emigration that is strongly linked to initial Sacramento River flow increases between mid-November and early January. Approximately 78 percent of winter-run Chinook salmon emigrates during this phase. The second phase is characterized by sustained high Sacramento River flows between early January and early March, and the third phase typically occurs 1 week after the release of fall-run Chinook salmon from the Coleman National Fish Hatchery. The remaining proportion of juvenile winter-run Chinook salmon emigrates during these last two phases. The age structure of emigrating juveniles is dominated by young-of-the-year fry, but also may contain some yearlings.

b. *Central Valley Spring-run Chinook Salmon*

CV spring-run Chinook salmon populations currently spawn in the Sacramento River below Keswick Dam, the low-flow channel of the Feather River, and in Sacramento River tributaries including Clear, Antelope, Mill, Deer, and Butte Creeks (CDFG 1998). The entire population of migrating adults and emigrating juveniles must pass through the portion of the action area located within the mainstem Sacramento River.

Adult CV spring-run Chinook salmon enter the Sacramento River in February and March, and continue to their upstream migration into June and July (CDFG 1998). In the Sacramento River, juveniles may begin migrating downstream almost immediately following emergence from the gravel with most emigration occurring from December through March (Moyle *et al.* 1989, Vogel and Marine 1991). Snider and Titus (2000) observed that up to 69 percent of CV spring-run Chinook salmon emigrate during the first migration phase between November and early January. The remainder of the CV spring-run Chinook salmon emigrates during subsequent phases that extend into early June. The age structure of emigrating juveniles is comprised of young-of-the-year and yearlings, although the exact composition of the age structure is not known.

c. *Central Valley Steelhead*

CV steelhead populations currently spawn in tributaries to the Sacramento and San Joaquin Rivers. The proportion of CV steelhead in this ESU that migrates through the action area is unknown. However, because of the relatively large amount of suitable habitat in the Sacramento River relative to the San Joaquin River, it is probably high. Adult CV steelhead may be present in the action area from June through March, with the peak occurring between August and October (Bailey 1954, Hallock *et al.* 1957). Juvenile steelhead emigrate through the action area from late fall to spring. Snider and Titus (2000) observed that juvenile steelhead emigration primarily occurs between November and June. The majority of juvenile steelhead emigrates as yearlings.

d. *North American Green Sturgeon*

Both adult and juvenile North American green sturgeon are known to occur within the lower reaches of the Sacramento River and Delta. Both adult and juvenile green sturgeon may use the Delta as a migratory, resting, or rearing habitat. Green sturgeon presence in the Delta could occur in any month, as juveniles may reside there during their first few years of growth. Adults are likely to be present in the winter and early spring as they move through the Delta towards their spawning grounds in the upper Sacramento River watershed. Following spawning, the fish will pass through the Delta again on their way back to the ocean, but the duration and timing of this event is not well understood in the Sacramento River system.

2. Status of Habitat within the Action Area

The action area outside of the upper channel section of the SDWSC is designated critical habitat for SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead. Habitat requirements for these species are similar. The essential features of freshwater salmonid habitat within the action area include: adequate substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, and safe passage conditions.

Within the lower section of the SDWSC, the Sacramento River has been transformed from a meandering waterway lined with a dense riparian corridor, to a highly leveed system under varying degrees of control over riverine erosional processes and flooding. Different types of riprap comprise the majority of shoreline habitat. Much of this existing riprap is located along the lower third of the levee, near or below the water surface. Due to the sparsity of riparian vegetation, LWD recruitment is low.

Water temperatures in the action area generally are most favorable for anadromous fish during the winter and spring months and may be warmer than desired conditions from late spring through early fall. High water temperatures primarily are caused by ambient air temperatures, but also are affected by the lack of riparian shading, and by thermal inputs from agricultural outfall water.

Habitat within the action area is primarily used as juvenile rearing habitat and as a migration corridor for adults and juveniles. The condition and function of this habitat has been severely impaired through several factors discussed in the *Status of the Species and Habitat* section of this biological opinion, including agricultural water development and land use practices, predation, and habitat fragmentation. The result has been the reduction in quantity and quality of essential habitat elements that are required by juveniles to survive and grow, such as water contamination and loss of shallow-water rearing and refugia habitat. In spite of the degraded condition, the importance of the area to the species is high because it is used for extended periods of time by a large proportion of all Federally listed anadromous fish species in the Central Valley. However, due to the currently degraded condition the function of the habitat is low.

In the upper section of the SDWSC, curtailed use of the lock since 1982 has reduced through-channel flow and led to water quality problems in the SDWSC, including high salinity and water temperatures (Corps 1995). In 1975, the Central Valley Regional Water Quality Control Board (Regional Board) adopted a basin plan that included water quality objectives for the SDWSC. Water quality data collected between 1963 and 1983 indicated that salinity levels frequently exceeded Regional Board standards (FWS 1995). Water temperatures in the SDWSC were recorded by the FWS (1995) from July 1994 to March 1995. Temperatures that are sublethal and lethal to juvenile and adult salmonids were observed near the lock during July and August. From July through August, the average daily water temperature exceeded 73 ^{o}F for all but two days. The maximum daily water temperature was 88.2 ^{o}F on July 26, 1994, and the highest daily average was 78.5 ^{o}F on July 30, 1994. Water temperatures remain above 70 ^{o}F until late September, and drop to below 60 ^{o}F by November (FWS 1995). Through the winter, temperatures range between 45 ^{o}F and 55 ^{o}F. Summer water temperatures in the upper SDWSC tend to be about 10 ^{o}F warmer than in the Sacramento River (Corps 1995).

Riparian vegetation and LWD along and within the upper ship channel is scarce. Emergent aquatic vegetation comprised of bulrush, cattail, and three-square bulrush grows sporadically along the edge of the channel; grasses and forbs grow along the levee slopes. Most of the shoreline is covered with riprap or maintained through vegetation removal and rock applications (Corps 1995). In-channel LWD and SRA habitat are important habitat components for rearing salmonids because they contribute to shade, food production, and cover from predators (FWS 2000). The sparse and sporadic distribution of SRA habitat in the SDWSC limits the value of the channel as rearing habitat for salmon and steelhead.

Warm water temperatures, high salinities, lack of riparian vegetation, and the presence of predators combine to create conditions that generally are unfavorable to rearing and outmigrating juvenile salmonids, especially when these conditions are compared to conditions of the Sacramento River. Past investigations have considered using the SDWSC as a juvenile bypass channel to reduce the exposure of anadromous fish to the Delta Cross Channel and Georgiana

Slough, where juvenile mortality rates are high (Corps 1995). However FWS (1995) concluded that poor habitat conditions in the SDWSC, including a lack of freshwater through-flow, a lack of riparian habitat, and high levels of predation were not suitable for juvenile rearing or outmigration, and that use of the channel would likely result in higher losses than if the fish were to remain in the main channel Sacramento River.

B. Factors Affecting the Species and Habitat in the Action Area

The magnitude and duration of peak flows during the winter and spring are reduced by water impoundment in upstream reservoirs. Instream flows during the summer and early fall months have increased over historic levels for deliveries of municipal and agricultural water supplies. Overall, water management now reduces natural variability by creating more uniform flows year-round. Current flood control practices require peak flood discharges to be held back and released over a period of weeks. Consequently, the river often remains too high and turbid to provide quality rearing habitat.

Levee construction and bank protection have affected salmonid habitat availability and the processes that develop and maintain preferred habitat by reducing floodplain connectivity, changing riverbank substrate size, and decreasing riparian habitat and SRA cover. Individual bank protection sites typically range from a few hundred to a few thousand linear feet in length. Such bank protection generally results in two levels of impacts to the environment: (1) site-level impacts which affect the basic physical habitat structure at individual bank protection sites; and (2) reach-level impacts which are the accumulated impacts to ecosystem functions and processes that accrue from multiple bank protection sites within a given river reach (USFWS 2000). Revetted embankments result in loss of sinuosity and braiding and reduce the amount of aquatic habitat.

The use of rock armoring limits recruitment of LWD because the relatively smooth and homogenous surface facilitates the downstream transportation of instream debris, and greatly reduces, if not eliminates, the retention of LWD once it enters the river channel. Riprapping creates a relatively clean, smooth surface which diminishes the ability of LWD to become securely snagged and anchored by sediment. LWD tends to become only temporarily snagged along riprap, and generally moves downstream with subsequent high flows. Habitat value and ecological function are thus greatly reduced, because the debris needs to remain in place to generate maximum values to fish and wildlife (USFWS 2000). Recruitment of LWD is limited to any eventual, long-term tree mortality and whatever abrasion and breakage may occur during high flows (USFWS 2000). Juvenile salmonids likely are being impacted by habitat reduction and fragmentation, and the general lack of connectedness of remaining nearshore refuge areas. Riprap reduces the amount of high value habitat available for juvenile salmonids to rear and grow, and makes them more susceptible to predation in the open water.

High water temperatures also limit habitat availability for listed salmonids in the lower Sacramento River (Boles *et al*. 1988). High summer water temperatures in the lower Sacramento River can exceed 72 ^{o}F and create a thermal barrier to the migration of adult and juvenile salmonids (Kjelson *et al*. 1982, Rich 1997). In addition, water diversions, for agricultural and municipal purposes, have reduced river flows and increased temperatures during the critical summer months limiting the survival of juvenile salmonids (Reynolds *et al*. 1993).

C. Likelihood of Species Continued Use of Habitat within the Action Area

The action area below CM 18.6 is located within a reach of the Sacramento River that is utilized by nearly all listed anadromous fish populations within the Sacramento River basin. SR winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and North American green sturgeon will continue to utilize the action area as a migratory corridor and for rearing. Because of the size and location of the action area, a large proportion of each ESU utilizes the action area as a migratory corridor or for rearing, making it an important node of habitat for the survival and recovery of SR winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and North American green sturgeon.

V. EFFECTS OF THE ACTION

Pursuant to section 7(a)(2) of the ESA (16 U.S.C. §1536), Federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat. NMFS will evaluate destruction or adverse modification of critical habitat by determining if the action reduces the value of critical habitat for the conservation of the species. This section discusses the direct and indirect effects of the construction and operation of the SDWSC Maintenance Dredging and Bank Protection project that are expected to result from the proposed action on SR winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the southern DPS of North American green sturgeon, or their designated critical habitat. Cumulative effects (*i.e.*, effects of future State, local, or private actions on endangered and threatened species or critical habitat) are discussed separately. The proposed project is likely to cause mainly adverse short-term effects to listed species and critical habitat. The project includes measures to avoid or minimize many potential impacts.

In the *Description of the Proposed Action* section of this biological opinion, NMFS provided an overview of the action. In the *Status of the Species* and *Environmental Baseline* sections of this biological opinion, NMFS provided an overview of the threatened and endangered species and critical habitat that are likely to be adversely affected by the activity under consultation.

Regulations that implement section 7(b)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. §1536; 50 CFR 402.02). Section 7 of the ESA and its implementing regulations also require biological opinions to determine if Federal actions would destroy or adversely modify the conservation value of critical habitat (16 U.S.C. §1536).

NMFS generally approaches "jeopardy" analyses in a series of steps. First, we evaluate the available evidence to identify the direct and indirect physical, chemical, and biotic effects of proposed actions on individual members of listed species or aspects of the species' environment (these effects include: direct, physical harm or injury to individual members of a species; modifications to something in the species' environment - such as reducing a species' prey base, enhancing populations of predators, altering its spawning substrate, altering its ambient temperature regimes; or adding something novel to a species' environment - such as introducing exotic competitors or a sound). Once we have identified the effects of an action, we evaluate the available evidence to identify a species' probable response (including behavioral responses) to those effects to determine if those effects could reasonably be expected to reduce a species' reproduction, numbers, or distribution (for example, by changing birth, death, immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; decreasing the age at which individuals stop reproducing; among others). We then use the evidence available to determine if these reductions, if there are any, could reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

To evaluate the effects of the proposed action, NMFS examined the proposed maintenance dredging operations, dredge material disposal operations, bank protection activities, habitat loss, and conservation measures, to identify likely impacts to listed anadromous salmonids and green sturgeon within the action area based on the best available information.

The primary information used in this assessment includes fishery information previously described in the *Status of the Species* and *Environmental Baseline* sections of this biological opinion; studies and accounts of the impacts of dredging, dredge material disposal, and bank protection activities on anadromous species; and documents prepared in support of the proposed action, including the Corps March 2004 Biological Assessment and April 2005 Supplemental Information for the Biological Assessment.

A. Approach to Assessment

1. <u>Information Available for the Assessment</u>

To conduct the assessment, NMFS examined an extensive amount of evidence from a variety of sources. Detailed background information on the status of these species and critical habitat has been published in a number of documents including peer reviewed scientific journals, primary reference materials, governmental and non-governmental reports, scientific meetings, and environmental reports submitted by the project proponents. Additional information investigating the effects of the project's actions on the listed species in question, their anticipated response to these actions, and the environmental consequences of the actions as a whole was obtained from the aforementioned resources. Final drafts of the plans for the fisheries monitoring and water quality monitoring programs proposed as part of the project have not been completed; therefore, NMFS has analyzed the effects of the project without relying on monitoring efforts to avoid or minimize effects on listed species.

2. <u>Assumptions Underlying This Assessment</u>

In the absence of definitive data or conclusive evidence, NMFS must make a logical series of assumptions to overcome the limits of the available information. These assumptions will be made using sound, scientific reasoning that can be logically derived from the available information. The progression of the reasoning will be stated for each assumption, and supporting evidence cited.

Additional information from fish monitoring studies conducted by the FWS and CDFG regarding salmonid density in the Sacramento River was incorporated into the calculations for risk assessment. Turbidity effects utilized information pertaining to salmonids in general, rather than to the specific listed species present in the action area due to a lack of direct information concerning their response.

The degree to which contaminants would be suspended during dredging and effluent return from dredge material placement sites, and the effects of the contaminants on listed salmonids are not clear. The Corps has tested sediments for contaminants across all areas where dredging is proposed. The Corps has not found contaminants in concentrations that exceed existing regulatory criteria. However, regulatory criteria have not been designated for all contaminants or life history events relevant to listed salmonids.

Another area of uncertainty in this consultation is how dredging or disposal effluent discharges actually distribute contaminants. If the dredging equipment contains the sediments effectively after excavation, the distribution of contaminants would be greatly minimized. Conversely, if contaminated sediments are not contained effectively, they could be widely distributed. This is the primary concern with disposal operations. Effluent return from disposal sites potentially would re-suspend any contaminants present. The Corps, however, has tested sediments within the action area and determined that they would not exceed existing regulatory thresholds for a range of contaminants.

The fate of salmon and steelhead that migrate into the upper section of the SDWSC is not completely understood. Prior to ceasing lock gate operations, fish could pass through to the Sacramento River when the gates were opened for navigation purposes. In at least one instance several hundred fish moved upstream through the lock when the gates were opened (Corps 1995). Salmon and steelhead blocked behind the lock gates are thought to be harvested by anglers, or die without spawning (FWS 1995).

The status of green sturgeon in the upper section of the SDWSC is unknown; however, more abundant white sturgeon (*Acipenser transmontanus*) have been captured in the Yolo Bypass toe drain, which is accessed from Cache Slough and is adjacent to the upper section of the SDWSC (Harrell and Sommer 2003).

B. Assessment

The Corps' maintenance dredging actions will occur for 10 dredging seasons from between June 1 and February 27 of each dredging year through 2015. Dredging from December 1 through February 27 will be conducted only in the upper section of the SDWSC located outside of the Sacramento River and Cache Slough. Dredging at a particular location is expected to occur intermittently, with an average dredging cycle of 3 to 4 years between actions for some highly accreting areas, while other sections may be dredged less than once per decade. Bank stabilization will occur as needed between June 15 and September 30 each year for the 10-year duration of this opinion, but only in the upper section of the SDWSC located outside of the Sacramento River and Cache Slough. Bank sections deemed in need of repair will be restored to their original configuration during the in-water work window designated in the project description. Project impacts on listed salmonids and North American green sturgeon are expected to include both direct impacts to fish present in the action area during the activities, and indirect impacts that may occur later in time or downstream, and adversely affect fish occurring in the action area at any time of the year. Direct adverse effects are expected to result from re-suspension of sediment and toxic chemicals, entrainment (including that of benthic food organisms), effluent return from DMP sites, and bank stabilization work. Exposure of listed salmonids to direct effects of the project is expected to be avoided or minimized largely because in-channel work in the mainstem Sacramento River (*i.e.*, in the lower section of the SDWSC) will occur primarily during the summer and fall, when salmonid abundance is expected to be low. Few salmonids or green sturgeon are anticipated to occur at all in the upper, manmade section of the SDWSC. Long-term, indirect effects are expected to result from impacts to habitat such as the removal of vegetation. A brief discussion of the likelihood of exposure of listed fish by month, species, and life stage follows:

For SR winter-run Chinook salmon, the work window for project activities in the mainstem Sacramento River and associated sloughs (June 1 to November 30) should preclude most instances of exposure to all but the earliest migrating adults and juveniles. Early adults are likely to be present in the action area only in December; early juveniles may be present in November and December, especially if significant rainfall events occur to trigger their outmigration behavior. The duration of exposure for straying adults in the manmade section of the SDWSC to the effects of the proposed project likely would be on the order of days.

No adult CV spring-run Chinook salmon are expected to occur in the action area during the period from June 1 through November 30. Yearling fish may appear in the Sacramento River as early as late October, but are not likely to occur in any substantial numbers until after February when the bulk of juvenile spring-run Chinook salmon begin to enter the Delta.

During the period between September and the end of November, adult CV steelhead may be in the proximity of the dredging and bank stabilization activities as proposed; however, NMFS expects them most likely to be present during the months of December through February, which is the peak of their spawning migration.

The peak of juvenile CV steelhead emigration from their tributaries in the Sacramento Valley occurs during the period between March and May. Therefore, conducting project activities in the Sacramento River reach of the SDWSC between June 1 and November should avoid impacts to the majority of juvenile CV steelhead smolts in this locale.

All SR winter-run Chinook salmon and CV spring-run Chinook salmon, and CV steelhead from the Sacramento River drainage have the potential to be exposed to the long-term effects of the Corps' maintenance dredging actions. The total number exposed to adverse effects associated with the altered habitat could range from several hundred to a few thousand individuals, depending on the timing of dredging activities and the run size for that year.

North American green sturgeon are anticipated to be present in small numbers throughout the action area during the Corps' activities. Although information for the density of green sturgeon presence currently is not available, their continual but infrequent occurrence in sampling studies targeting other fish species indicates that they may be present throughout the year within the mainstem Sacramento River and thus vulnerable to both short-term and long-term adverse effects of the project.

1. Turbidity

Dredging and the disposal of dredged materials would disturb and suspend a significant volume of benthic sediment. Previous estimates of dredge created turbidity have indicated that dredging will result in an increase in total suspended solids downstream of the dredging action, which should not greatly change conditions in the SDWSC compared to background turbidity levels.

Quantifying turbidity levels, and their effect on fish species, is complicated by several factors. First, turbidity from an instream activity will typically decrease as distance from the activity increases. How quickly turbidity levels attenuate depends on the quantity of materials in suspension (*e.g.*, mass or volume), the particle size of suspended sediments, the amount and velocity of ambient water (dilution factor), and the physical/chemical properties of the sediments. Second, the impact of turbidity on fishes is not only related to the turbidity levels, but also the particle size of the suspended sediments.

For salmonids, the moderate levels of turbidity expected to be generated by the proposed action may elicit a number of behavioral and physiological responses (*i.e.*, gill flaring, coughing, habitat avoidance, increase in blood sugar levels) which indicate some level of stress (Bisson and Bilby 1982, Sigler *et al.* 1984, Berg and Northcote 1985, Servizi and Martens 1992). The magnitude of these stress responses is generally higher when turbidity is increased and particle size decreased (Bisson and Bilby 1982, Servizi and Martens 1987, Gregory and Northcote 1993). Although turbidity may cause stress, Gregory and Northcote (1993) have shown that moderate levels of turbidity (35-150 Nephelometric Turbidity Units (NTU)) accelerate foraging rates among juvenile Chinook salmon, likely because of reduced vulnerability to predators (camouflaging effect).

When the particles causing turbidity settle from the water column, they contribute to sedimentation. Turbidity and subsequent sedimentation can influence the exchange of streamflow and shallow alluvial groundwater, depress riverine productivity, and contribute to decreased salmonid growth rates (Waters 1995, Newcombe and Jensen 1996).

The Corps proposes the use of suction dredging, which involves excavating sediments with a cutterhead suction dredge. Suction dredging has the potential to create turbidity primarily where the excavation is occurring as the interface between the excavating apparatus and sediments is not contained. It is expected that turbidity resulting from dredging and dredged material disposal would be intense in the vicinity of the activity themselves, but would rapidly attenuate with time and space. The conservation measures proposed to minimize the impacts of hydraulic dredging (*e.g.*, reducing the cutterhead rotation speed and reducing swing speed) specifically are intended to reduce the volume of and broadcast area of suspended sediment and should preclude large changes to the conditions in the SDWSC compared to background turbidity levels.

The Corps would implement a number of additional techniques to minimize turbidity effects resulting from project operations. First, the Corps would monitor turbidity levels and modify dredging operations to avoid prolonged negative effects. Second, the Corps would dispose of dredge material in a manner to limit the exposure of listed fish by placing the material in upland disposal sites and by meeting water quality standards for effluent discharge from these sites. The Corps also would use BMPs at disposal locations to prevent remobilization of sediments, and subsequent turbidity, through dewatering activities or storage.

Based on the timing of the dredging actions in the mainstem Sacramento River (June 1 through November 30), NMFS expects the majority of the impacts created by dredging activity to be experienced by adult CV steelhead migrating upstream to the watersheds of the Sacramento River and early migrating Sacramento winter-run Chinook salmon juveniles passing into the Central Delta from the Sacramento River system during the later portion of the dredging season. Although some steelhead smolts may be migrating downstream at this time, their numbers are expected to be low compared to the peak of migration in spring and would tend to be associated with rain events or pulse flow operations on the tributaries. Increased flows in the main channel of the Sacramento River resulting from pulse flows or winter precipitation would be expected to ameliorate the negative effects of the dredging action by shortening the duration of migration through the action area and diluting the resuspended sediments in the water column. Similarly, winter-run Chinook salmon juveniles often exhibit early migrational behavior that is correlated with rainfall events and increased turbidity in the Sacramento River. The exposure risk to green sturgeon is less clear. It can be anticipated that juvenile and adolescent green sturgeon could be found year-round in the Sacramento River, particularly in the deeper sections of the SDWSC based on sturgeon behavior and their preference for deep holes in river channels.

2. <u>Contaminants</u>

Disturbing benthic sediments through dredging and dredge material disposal, and effluent return from DMP sites, is expected to mobilize and distribute a variety of contaminants. The Corps has identified polycyclic aromatic hydrocarbons (*i.e.*, PAHs), organophosphates, chlorinated herbicides, ammonia, oil, grease, glyphosate, a-amino-3-hydroxy-5-methyl-4-isoxazolepro-pionate (*i.e.*, AMPA), dioxin, heavy metals, and other, as potential contaminants. Some of these contaminants may be acutely or chronically harmful to salmonids (Allen and Hardy 1980). The Corps has tested sediments for contaminants across all areas where dredging is proposed, and has not found contaminants in concentrations that exceed existing regulatory criteria. However, many contaminants lack defined regulatory exposure criteria that are relevant to listed salmonids, and may have unknown effects on salmonids (Ewing 1999).

If contaminants are released during dredging or disposal activities, their effects may be subtle and difficult to directly observe. The effects of bioaccumulation are of particular concern as pollutants can reach concentrations in higher trophic level organisms (*e.g.*, salmonids) that far exceed ambient environmental levels (Allen and Hardy 1980). Bioaccumulation may therefore cause delayed stress, injury, or death as contaminants are transported from lower trophic levels (*e.g.*, benthic invertebrates or other prey species) to predators long after the contaminants have entered the environment or food chain. It follows that some organisms may be adversely affected by contaminants while regulatory thresholds for the contaminants are not exceeded during measurements of water or sediments.

Sublethal or nonlethal endpoints don't require that mortality be absent; rather it indicates that death is not the primary toxic endpoint being examined. Rand (1995) states that the most common sublethal endpoints in aquatic organisms are behavioral (*e.g.*, swimming, feeding, attraction-avoidance, and predator-prey interactions), physiological (*e.g.*, growth, reproduction, and development), biochemical (*e.g.*, blood enzyme and ion levels), and histological changes. Some sublethal effects may indirectly result in mortality. Changes in certain behaviors, such as swimming or olfactory responses, may diminish the ability of the salmonids to find food or escape from predators and may ultimately result in death. Some sublethal effects may have little or no long-term consequences to the fish because they are rapidly reversible or diminish and cease with time. Individual fish of the same species may exhibit different responses to the same concentration of toxicant. The individual condition of the fish can significantly influence the outcome of the toxicant exposure. Fish with greater energy stores will be better able to survive a temporary decline in foraging ability, or have sufficient metabolic stores to swim to areas with better environmental conditions. Fish that are already stressed are more susceptible to the deleterious effects of contaminants, and may succumb to toxicant levels that are considered sublethal to a healthy fish

Exposure to sublethal levels of contaminants might have serious implications for salmonid health and survival. Recent studies have shown that low concentrations of commonly available pesticides can induce significant sublethal effects on salmonids. Scholz *et al.* (2000) and Moore and Waring (1996) have found that diazinon interferes with a range of physiological biochemical pathways that regulate olfaction, adversely affecting homing, reproductive, and anti-predator behavior of salmonids. Waring and Moore (1997) also found that the carbofuran had significant effects on olfactory mediated behavior and physiology in Atlantic salmon (*Salmo salar*). Ewing (1999) reviewed scientific literature on the effects of pesticides on salmonids and identified a wide range of sublethal effects such as impaired swimming performance, increased predation of juveniles, altered temperature selection behavior, reduced schooling behavior, impaired migratory abilities, and impaired seawater adaptation.

Other non-pesticide compounds that are common constituents of urban pollution and agricultural runoff also adversely affect salmonids. Exposure to chlorinated hydrocarbons and aromatic hydrocarbons causes immunosuppression and increased disease susceptibility (Arkoosh *et al.* 1994). In areas where chemical contaminant levels are elevated, disease may reduce the health and survival of affected fish populations (Arkoosh *et al.* 1994).

As noted above, there is a growing body of literature that suggests small amounts of certain contaminants may affect the biology of salmonids. At present, regulatory thresholds are likely inadequate to account for these effects (*i.e*., some contaminants do not have salmonid exposure criteria or bioaccumulation criteria). Therefore, we expect the proposed action to have sublethal effects on listed salmonids as described above. We also anticipate green sturgeon to experience sublethal effects to the same or a greater extent than listed salmonids due to their year-round presence in the action area, and dermal contact with sediment because of their benthic lifestyle.

It is expected that exposure criteria will be refined and expanded in the future. In the meantime, the Corps has committed to conservation measures that minimize the exposure of listed salmonids to contaminants. The Corps would continue to sample sediments for contaminants, refrain from inwater disposal of contaminated sediments, and would implement BMPs to prevent fuels spills, hydraulic leaks, *etc*. during dredging and disposal operations.

3. <u>Entrainment and Harassment</u>

NMFS believes the probability of entraining SR winter-run Chinook salmon, CV spring-run Chinook salmon or CV steelhead in the hydraulic dredge is very low because these fish are likely to avoid the immediate vicinity of dredging operations, and because dredging operations proceed slowly. Additionally, the Corps has committed to a number of conservation measures to reduce the probability of entrainment occurring during future dredge operations. Direct effects to listed steelhead and Chinook salmon species by entrainment, though minimal, can be avoided by not operating the dredge when the cutterhead is off the river bottom. The cutterhead would remain on the bottom of the water column to the greatest extent possible and only be raised 3 feet off the bottom when necessary during maintenance dredging operations. The cutterhead suction pumps would only be turned on when necessary with the cutterhead not more than 3 feet off the channel bottom.   This measure is primarily for juveniles because adults have sufficient swimming capacity to avoid entrainment unless they swim directly into the cutterhead.

Furthermore, most dredging will take place in water deeper than 20 feet. It is not anticipated that steelhead or Chinook salmon smolts would be at this depth during their seaward migration, thus further insulating them from the effects of the flow fields surrounding the cutterhead. Adult salmonids that may encounter the hydraulic dredge would likewise be able to avoid and escape entrainment due to their greater swimming speed. Overall, no adults and few juvenile listed salmonids are expected to be entrained in the dredge, although any fish entrained in the dredge would be expected to die due to physical injury or suffocation in sediment coupled with the unlikelihood of release back into the river channel once entrained.

Juvenile and adolescent green sturgeon may be at an elevated risk of entrainment from the hydraulic dredge. Based on data for salmon entrainment (Reine and Clark 1998), sturgeon juveniles were entrained at high rates on the Columbia River from localized areas known to have aggregations of sturgeon (sturgeon holes). The behavior of sturgeon apparently places them at risk to dredging actions due to their preference for deep channels and holes (*i.e.,* the SDWSC) and their reluctance to move away from those areas even when disturbed. Since NMFS assumes that the green sturgeon will occupy the Sacramento River habitat year-round during their juvenile and sub-adult phases, exposure to entrainment may occur throughout the entire dredging window for the SDWSC.

4. Rearing Habitat

The Corps proposes to annually dredge approximately 500,000 acre feet of silt and sand accumulations in portions of the lower Sacramento River and artificial channel of the SDWSC. These number, location, and size of these sites will vary from year to year and will represent varying degrees of suitability as juvenile rearing habitat for the subject ESUs. Suitability is determined in part by depth, substrate type, and distance from the shoreline.

The most important habitat attribute of the riverbed to listed ESUs in this portion of the Sacramento River is the production of food items for rearing and migrating juveniles. Oligochaetes and chironomids (dipterans) are the dominant juvenile Chinook salmon, steelhead, and North American green sturgeon food items produced in the silty and sandy substrates in this area.

Populations of these organisms would be entrained by the hydraulic suction dredge, particularly small demersal fish and benthic invertebrates. The Corps report (Reine and Clark 1998) estimated that the mean entrainment rate of a typical benthic invertebrate, represented by the grass shrimp, when the cutterhead was positioned at or near the bottom was 0.69 shrimp/cubic yard but rose sharply to 3.4 shrimp/cubic yard when the cutterhead was raised above the substrate to clean the pipeline and cutterhead assembly. Likewise, benthic infauna, such as clams, would be entrained by the suction dredge in rates equivalent to their density on the channel bottom, as they have no ability to escape. The loss of benthic food resources, such as amphipods or isopods, could reduce fish growth rates and increase the energy expended searching for food, depending on the density of the animal assemblages on the channel bottom. This would be more likely to occur to sturgeon, which are specialized benthic feeders, but also may affect juvenile salmon and steelhead. NMFS believes that small invertebrates such as annelids, crustaceans (amphipods, isopods), and other benthic fauna would be unable to escape the suction of the hydraulic dredge and be lost to the system. Also, many benthic invertebrates have pelagic, surface-oriented larvae; therefore the loss of these benthic invertebrates may reduce the abundance of localized zooplankton populations in the upper regions of the water column where juvenile salmonids migrate through the SDWSC. The timing of the dredging cycle (summer-fall) may preclude forage base replacement by recruitment from surrounding populations prior to the following winter and spring migration period of juvenile steelhead through the dredging action area (Nightingale and Simenstad 2001). Additionally, as these organisms occupy habitat types that are prone to disturbance under natural conditions, they would likely rapidly recolonize dredged areas by drifting and crawling from adjacent non-disturbed areas (*e.g.*, Mackay 1992).

The time needed to recolonize the dredged area is unknown and is complicated by the variable maintenance dredging cycles and reach locations. These variable dredging cycles may preclude a "natural climax" benthic invertebrate assemblage from re-establishing itself in a given specific reach of the SDWSC. However, outmigrating salmonids and rearing green sturgeon should be able to find alternative foods and foraging areas outside of the channel and in adjoining channels feeding into the SDWSC. Overall, the maintenance dredging is not likely to change the benthic habitat to the extent that listed species would be adversely affected in the reaches to be dredged, particularly in the upper manmade section of the SDWSC.

5. Bank Stabilization

Construction activities associated with stream bank protection may facilitate the transport of sediment into the stream channel and increase turbidity resulting from precipitation events. The effects of suspended sediment and turbidity on fish are discussed above.

The use of rock riprap to stabilize streams can substantially alter both site conditions and adjacent riverbed and riverbank habitat, thereby significantly reducing suitability of the habitat for salmonids. Although rock riprap can provide some habitat features used by salmonids, such as inter-rock space, there is increasing evidence that fish densities at rock riprap banks are reduced (Schmetterling 2001). The use of rock riprap to stop bank erosion by its nature tends to change riverbed and riverbank characteristics, and can effectively change the physical processes that maintain a dynamic equilibrium of stream system form and function. The following generalized discussion of the effects of bank stabilization on fish habitat applies to the proposed action.

A comparative review of effects of riprap (Schmetterling 2001) has indicated that fish densities at stream locations with riprap banks are reduced as compared to areas with natural banks. This is true even when compared to actively eroding cut banks (Schaffter *et al.* 1983, Michny and Deibel 1986). The use of riprap either results in site characteristics that limit suitability for fish at various life stages (Li *et al.* 1984, Beamer and Henderson 1998, Peters *et al.* 1998, North *et al.* 2002), or perpetuates detrimental conditions that may restrict or limit fish production, such as channelizing the stream (Knudson and Dilley 1987). Even when rock may contribute to habitat diversity within the alluvial stream system, in the immediate area habitat complexity is simplified and beneficial biological responses tend to be of limited duration and have greater variability (Beamer and Henderson 1998, Peters *et al.* 1998, Schmetterling 2001). The effect of rock riprap varies with fish species and age class. Chinook salmon often are effectively displaced from riprap sites, although there has been some limited occurrence of Chinook salmon associated with rock barbs during spring flows (Li *et al.* 1984, Beamer and Henderson 1998, Peters *et al.* 1998, North *et al.* 2002). Rainbow trout (and by inference, steelhead) were less affected than Chinook salmon, showing a limited preference for rip-rap and rock barbs (Li *et al.* 1984, Beamer and Henderson 1998, Peters *et al.* 1998). Decreases in juvenile fish densities were more evident than in adults, including juvenile rainbow trout (Li *et al.* 1984, Beamer and Henderson 1998). Rock riprap can also result in increased densities of predatory fish (Knudson *et al.* 1987, North *et al.* 2002).

The use of rock riprap effectively changes the localized hydraulics, substrate, and available food and cover for fish at stream sites where it is used. There is an indication that the flow regimes created by rock riprap significantly disrupt juvenile fish. Juvenile fish are associated with lower velocity flows at the riverbed interface, holding for food, finding potential hiding places in the gravels, and/or avoiding larger predatory fish in deeper waters. Rock riprap can disrupt flows, reduce food delivery, and create difficult swimming for smaller fish (Schaffter *et al.* 1983, Michny and Deibel 1986). During higher spring flows, juvenile Chinook salmon were found behind spur dikes (Li *et al.* 1984).

These features can provide a simplified flow modulator for a limited period of time. Complex large wood associated with banklines, even at riprap banks, demonstrates more flow modulation over greater time frames at different water elevations, as well as providing the small intricate space for juveniles to escape predation (Peters *et al.* 1998, Beamer *et al.* 1998). In general, juveniles tend to hug the banks during winter and spring (seeking refuge from higher flows, food, and cover) and tend to move to the main channel during summer. Adults tend to be more oriented to the deep channel, and utilize eddy lines and flow deflectors (Li *et al.* 1984, Carlson *et al.* 2000). Where more natural bankline features occur, and shallow water gravel benches or large complex wood deposits have been either maintained or incorporated into riprap, fish densities are improved (Schaffter *et al.* 1983, Michny and Deibel 1986, Beamer and Henderson 1998, Peters *et al.* 1998).

Riprap not only modifies the riverbed and riverbank habitat, but as its primary purpose, it stops natural stream processes that maintain a functioning stream system. By “fixing” the stream, rock riprap limits habitat formation and transitions that result from dynamic stream processes. This reduces the likelihood that adverse effects from riprap would be mitigated over time. Stream migration, channel changes, flooding, ground water interchange, gravel supply, and large wood supply are significant elements of natural stream processes that can be impacted by riprap. It is generally understood that vegetated stream edges, floodplains, and riparian areas contribute to supporting fish and the stream system as a whole. This is true of the subsurface hyporheic zone (Bolton and Shellberg 2001). Stream erosion and adjustments are natural processes to which fish have adapted. A typical disturbance such as channel degradation or significant alteration is followed by formation over time of various stream system features that existed before the alteration, including floodplain and stable vegetated hillslopes and riparian areas (Bolton and Shellberg 2001). Stabilizing banks with rock riprap fixes the stream in place, and limits any adjustment processes and/or formation of natural stream features.

Adult fish migration is affected by stream obstructions, water quality, and stream flow. Active stream channel migration typically will maintain a deep water channel feature and provide for the upstream movement of adult salmon. Bank stabilization activities associated with the proposed action would tend to fix the location of the channel, resulting in localized changes to the channel form, deepening some areas and shallowing other areas. The project area has been extensively leveed. The restriction of riprap activities to the manmade section of the SDWSC will not result in a substantial change in stream channel processes. Furthermore, the proposed action is not expected to directly or indirectly block the stream channel or affect flows to the extent that they would impair the migration of salmonids or North American green sturgeon.

Juvenile salmon rear within the project area and emigrate past the project area during winter and early spring. Juvenile salmonids require food, cover, and refuge from high velocity flows. Although the fine sediments associated with the project’s location do not typically produce substantial numbers of invertebrates used by salmon, terrestrial and aquatic invertebrates can accumulate at this location from riparian or upstream sources. Shallow water areas and small structural elements that create localized eddy currents can provide space for juveniles to hide and avoid predation. During high water events, flooding of stream terraces can introduce new food sources and provide the shallow-water, low-velocity space for juvenile refuge. The proposed action will limit formation of channel features and habitat used by juveniles for feeding, hiding, and refuge. The placement of rock riprap can increase channel scour, limit active channel forming processes, and simplify available habitat during high water. Rock riprap does add structure with openings between rocks. Larger rocks provide bigger spaces that may be used by salmon for feeding and hiding. The current natural channel has been affected by local land uses that have restricted stream migration. The proposed action is the maintenance of existing riprap in the artificial ship channel only and therefore will not significantly add to, or further restrict, stream processes and diversity and the development of complex stream channel habitat.

Currently the riverbank has been simplified through the construction of levees and the removal of riparian vegetation. Hardening the bank will limit potential for establishing vegetative structure and diverse pool habitat at the edge of the bank. However, the proposed action would add some structure and roughness to the stream along the edge and create space for juvenile salmon feeding and hiding. Green sturgeon, which prefer deeper habitat, would be less affected by bank stabilization activities.

VI. CUMULATIVE EFFECTS

For purposes of the ESA, cumulative effects are defined as the effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR §402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultations pursuant to section 7 of the ESA.

Non-Federal actions that may affect the action area include ongoing agricultural activities and increased urbanization. Agricultural practices in the action area may adversely affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow in stream channels flowing into the Sacramento River and Delta. Unscreened agricultural diversions along the Sacramento River and throughout the Delta entrain fish including juvenile salmonids. Grazing activities from dairy and cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which then flow into the receiving waters of the Sacramento River and Delta. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may adversely affect salmonid reproductive success and survival rates (Dubrovsky *et al.* 1998, 2000; Daughton 2003).

VII. INTEGRATION AND SYNTHESIS

In general, the direct adverse effects to Chinook salmon and steelhead in the SDWSC will be substantially attenuated by the work window proposed by the Corps, which will greatly reduce the exposure of listed salmonids. Dredging activities are to be restricted to the period between June 1 and November 30 in the main channel of the Sacramento River and Cache Slough, although effluent from the DMP sites may continue to enter the SDWSC for a period of time (*e.g.*, 1 month) after the work window ends. Bank protection activities will take place during the period between June 15 and November 30 with all inwater work limited to the period between June 15 and September 30. The proposed work window will avoid the majority of steelhead migration through the SDWSC from the Sacramento River basin. In the action area, adult and juvenile steelhead are expected to be exposed primarily during late November and December, when cool and rainy weather is likely to promote migration. Likewise, early downstream juvenile emigrants of the winter-run and spring-run Chinook salmon runs from the Sacramento River basin should not enter the action area until at least late October and more likely late November to early December when dredging in the main channel of the Sacramento River and Cache Slough is nearing completion. Few adult winter-run Chinook salmon and no adult spring-run Chinook salmon are expected to be exposed to the direct adverse effects of the project. Green sturgeon presence within the action area is considered to be year-round, with juveniles entering the Delta during the late summer and fall and potentially rearing there for several months to years before migrating to the ocean. However, because SR winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and North American green sturgeon are expected to occur primarily in the lower section of the SDWSC, which forms part of the major migration corridor through the Sacramento River drainage, fish from these ESUs/DPSs are expected to be exposed to the effects of the project mostly in the lower 18.6 miles of the project area. Very few listed fish should be exposed to the adverse effects of bank protection activities in particular, because these activities will occur only in the upper, manmade section of the SDWSC. The proposed action is expected to contribute to the continuation of poor quality habitat conditions in the SDWSC that may be experienced by fish present throughout the year.

A. Effects on Listed and Proposed Species

The short-term effects of the proposed project are expected to result in an increase in the near field suspended sediment ambient loads, which should not greatly change conditions in the SDWSC compared to background turbidity levels. Furthermore, the increased turbidity zone should be concentrated near the bottom of the channel within close proximity of the cutterhead before being diluted by water flow in the channel. Therefore, few listed salmonids in the action area are expected to be directly affected by the turbidity levels generated by the project, as salmonids should occupy the shallower, near surface water levels during emigration. Overall, the changes in turbidity and suspended sediment associated with this project therefore are expected to adversely affect listed species primarily by low-level, long-term alteration of habitat conditions, which may affect feeding or predation rates. The potential for the increase in suspended sediment to adversely affect green sturgeon is unclear. Although sturgeon are demersal fish closely associated with the bottom substrate, and therefore could be exposed to the elevated zones of turbidity along the bottom, they also are well-suited for these conditions. In particular, they feed by taste and feel with their barbels, even shoveling up sediment with their snouts when searching for food (Moyle 2002). Adverse effects are more likely to occur from entrainment of small individuals in the dredge.

The contaminants associated with the dredge material and the exposure of the new horizon may adversely affect exposed aquatic organisms. The levels of contaminants present in the sediment may not exceed the acute toxicity concentrations or the different water quality guidelines even if the sediment quality criteria are exceeded. Nevertheless, their elevated concentrations do present an increased risk to the health of exposed salmonids even though the exposure may not result in immediate mortality.

Decant waters from DMP sites are not expected to be experienced by all migrating salmonids to the same degree due to the temporal and spatial variances of the swim path of the fish and the location of the discharge plume. Fish that migrate near the riverbank will be more likely than fish in the middle of the channel to encounter the discharge plume during their upstream movements. Likewise fish that move during periods of discharge will have the potential to encounter the discharge plume compared to fish that move through the river system when there is no discharge.

The hydraulic suction head of the dredge creates a zone of inflow around the cutterhead of the dredge. Animals that venture too close to the cutterhead have the potential to be entrained into the suction pipeline of the dredge and carried to the DMP site on shore. As described previously, the Corps has indicated that dredging will take place in the main channel Sacramento River and Cache Slough between June 1 and November 30 to avoid the majority of listed salmonids in the SDWSC. The dredge will be operated at least 20 feet below the water surface, with the hydraulic suction and cutterhead operating only in the bottom substrate. The cutterhead may be raised briefly to clear obstructions, but never more than 3 feet above the substrate. It is NMFS' position that fish entrainment by the hydraulic dredging in this project scenario represents a very unlikely source of take due to the timing of dredging, the depth, and the flow fields around this particular dredging operation. In order for entrainment of steelhead (or other salmonids) to occur, the fish would have to be concentrated around the dredge head or the dredge operated at water depths where the salmonids would normally be aggregated.

The behavior of sturgeon places them more at risk than salmonids for entrainment into the hydraulic dredge. Sturgeon are benthically-oriented fish, maintaining position on or just above the bottom substrate. This places them within the operating zone of the hydraulic dredge. Sturgeon also tend to preferentially congregate in deep holes or channels where they "rest" or hold position for long periods of time. These deep holes along the channel of the SDWSC would place congregating sturgeon in the path of the dredging operations. An additional concern is the "lethargic" resting behavior of sturgeon, which could potentially allow the dredges to come within close proximity of the fish prior to eliciting an escape response. Reine and Clarke (1998) reported that white sturgeon on the Columbia River were entrained at an overall rate of 0.015 fish/cubic yard of material dredged, but were entrained in substantial numbers primarily from one location locally known as the "sturgeon hole." These fish ranged in size from 30 cm to 50 cm, which would correspond to juvenile-sized fish. These sizes are similar to those of green sturgeon that would be expected to be found in the action area.

NMFS believes that the dredging action will remove benthic invertebrates from the channel environment along length of the SDWSC, which represents a loss of forage base to outmigrating salmonids and rearing green sturgeon. The time needed to recolonize the dredged area is unknown and is complicated by the variable maintenance dredging cycles and reach locations. These variable dredging cycles may preclude a "natural climax" benthic invertebrate assemblage from re-establishing itself in a given specific reach of the SDWSC. However, outmigrating salmonids and rearing green sturgeon should be able to find alternative foods and foraging areas outside of the channel and in adjoining channels feeding into the SDWSC. Overall, the maintenance dredging is not likely to change the benthic habitat to the extent that listed species would be adversely affected in the reaches to be dredged.

B. Effects on Species Likelihood of Survival and Recovery

NMFS anticipates that the proposed project will result in the exposure of a small number of listed salmonids to adverse effects from increased levels of turbidity and suspended sediment, contaminants, entrainment, habitat loss, and bank stabilization. Fish exposure to DMP effluent would be intermittent and based on local hydrology, tides, and the spatial and temporal position of migrating fish. The elevated stress levels and contaminants may degrade the fish's health and the reproductive potential of adults, and increase the potential of juveniles to be preyed upon by striped bass or other large predators due to impaired behavioral and physiological responses. Individuals that appear different in their behavior attract predators, and thus experience higher mortality due to predator attacks.

Adult and juvenile steelhead are expected to be present in the action area primarily during late November and December. Similarly, NMFS does not expect that juvenile winter-run Chinook salmon will be present in the action area until late in the dredging work window; a few late-migrating adults may be present in June. The preceding information indicates overall that exposure of listed salmonids to effluent from the DMP sites should be infrequent and involve very few individuals, although decant water can continue to discharge for several days to weeks from the DMP sites following the cessation of active dredging in the mainstem Sacramento River and Cache Slough during late November. Exposed individuals are expected to be primarily outmigrating juveniles and smolts.

NMFS does not anticipate that CV spring-run Chinook salmon adults will occur in the action area during the dredging work window or soon after its closure, and therefore are not likely to be directly affected by activities such as the dredging or bank stabilization activities. Also, the likelihood of juvenile spring-run Chinook salmon being present in the Sacramento River during the dredging work window is low. Yearling fish may appear in the Sacramento River as early as late October, but are not likely to occur in any substantial numbers until after February when the pulse of emigrating juvenile spring-run Chinook salmon begin to enter the action area. The exposure potential of spring-run Chinook salmon to the decant water is expected to involve few fish, as the DMP sites are expected to have drained prior to the major influx of juveniles into the waters action area, unless there is substantial winter precipitation.

For all three of the listed salmonid ESUs/DPSs, no spawning or major freshwater rearing habitat will be affected by the proposed activities, so impacts on spawning survival and survival from egg to smolt are not expected. The very small loss of juveniles and smolts anticipated would be unlikely to result in a change in adult returns, because the number expected to be lost is small in comparison to the number produced and likely to survive to become adults.

North American green sturgeon are expected to be more vulnerable than salmonids to the adverse effects of dredging due to their benthic-oriented behavior which puts them in close contact with the contaminated sediment horizon. Their “inactive” resting behavior on substrate puts them in dermal contact with contaminated sites which can lead to lesions and the production of tumors from materials in the substrate. Sturgeon also are benthic invertebrate feeders that forage on organisms that can sequester contaminants at much higher levels than the ambient water or sediment content, such as the Asian clams *Corbicula* and *Potamocorbula* that are prevalent in the action area. The great longevity of sturgeons also places them at risk for the bioaccumulation of contaminants to levels that create physiologically adverse conditions within the body of the fish. Because they prefer deep pools, green sturgeon may have some reduced risk of exposure to effluent from DMD sites, which will be released in the shallow water margins of the river channel.

Little is known about the migratory habits and patterns of either adult or juvenile green sturgeon in the Delta region. The basic pattern described for adult green sturgeon migrations into the Delta region from the San Francisco Bay estuary is that fish enter the Delta region starting in late winter or early spring and migrate upstream towards the stretch of the Sacramento River between Red Bluff and Keswick Dam. After spawning, adults return downstream and re-enter the Delta towards late summer and fall (based on behavior of sturgeon in the Klamath and Rogue River systems). Juvenile and larval green sturgeon begin to show up in rotary screw trap catches along the Sacramento River starting in summer (Beamesderfer *et al.* 2004) and could be expected to reach the Delta by fall. The extent and duration of rearing in the Delta is unclear (*i.e.*, months to years), but NMFS believes that juvenile green sturgeon, including sub-adults, could be found during any month of the year within the waters of the Delta. Therefore, both adult and juvenile green sturgeon have the potential to be adversely affected by exposure to contaminants, and entrainment due to the project. These fish are likely to be in the vicinity of the lowermost dredging, DMP, and bank stabilization sites year-round.

Due to the lack of population abundance information regarding the southern DPS of North American green sturgeon, a variety of estimates must be utilized to determine the range of effects resulting from the take of a small number of green sturgeon. Compared to the estimated population sizes suggested by the CDFG tagging efforts (CDFG 2002), juvenile and sub-adult captures passing Red Bluff Diversion Dam, and past IEP sampling efforts, the lethal take would remove a small proportion of the adult and sub-adult North American green sturgeon population in the Sacramento River watershed. Ratios of tagged white to green sturgeon in San Pablo Bay have generated population estimates averaging 12,499 sub-adult and adult green sturgeon. Captures of juvenile and sub-adult green sturgeon passing Red Bluff Diversion Dam have exceeded 2,000 individuals in some years. Incidental take of both adult and juvenile North American green sturgeon is expected to represent a relatively small proportion of the standing population and is not expected to jeopardize the continued existence of the Southern DPS of North American green sturgeon.

C. Effects of the Proposed Action on Critical Habitat

The SDWSC Maintenance Dredging and Bank Protection project is likely to adversely affect the designated critical habitat of SR winter-run Chinook salmon, CV spring-run Chinook salmon and CV steelhead. Routine maintenance dredging will prevent future shoaling, continue to remove and expose new horizons of sediment with each dredging cycle, and periodically contribute to the suspended sediment, noise, and contaminant levels of the action area.

The dredged SDWSC will act as a collecting basin for materials carried along by the flow of the Sacramento River. Furthermore, the maintenance of the cross-sectional area of the channel will maintain the artificial volume of the channel compared to that which would naturally occur, and thus is expected to slow down the flushing velocity of the ambient river flow, and allow suspended material to settle out of the water column within the SDWSC. The constant adjusting of the channel cross section from that which normally occurs through equilibrium of the natural energy and sediment budgets to those of the artificially maintained channel dimensions perpetuates the need for dredging and the reduction of flow velocity throughout the channel.

The lower Sacramento River and Delta currently has marginal habitat quality due to anthropogenic alterations committed over the previous 150 years. These alterations include extensive levee construction, installation of rock slope protection on the levee faces (riprapping) which typically requires the removal of riparian vegetation, dredging of channels to enhance water diversions for agricultural and municipal purposes, straightening of channels to enhance water flow for flood control and water diversion purposes, and the discharge of agricultural and municipal waste effluents into the river channel at numerous locations within the Sacramento River and Delta.

In July, 2005, NMFS' critical habitat analytical review teams (CHARTs) issued their final assessments of critical habitat for 7 listed salmon and steelhead ESUs in California (NMFS 2005d). This included critical habitat descriptions for the CV spring-run Chinook salmon ESU and the CV steelhead DPS. Section 3 of the ESA (16 U.S.C. 1532(5)) defines critical habitat as "(i) the specific areas within the geographic area occupied by the species, at the time of the listing * * * on which are found those physical and biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection". These features include, but are not limited to, space for individual and population growth and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, and rearing of offspring; and habitats that are protected from disturbance or are representative of the historical geographical and ecological distribution of the species. After considering the above features, the CHARTs considered the principal biological and physical constituent elements that are essential to the conservation of the species, known as PCEs. The specific PCEs considered in determining the critical habitat for listed salmonids in California include (NMFS 2005b):

(1) **Freshwater spawning sites** with sufficient water quantity and quality and adequate substrate to support spawning, incubation and larval development.

(2) **Freshwater rearing sites** with sufficient water quantity and floodplain connectivity to form and maintain physical habitat conditions and allow salmonid development and mobility; sufficient water quality to support growth and development; food and nutrient resources such as terrestrial and aquatic invertebrates and forage fish; and natural cover such as shade, submerged and overhanging large woody debris, log jams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

(3) **Freshwater migration corridors** free of obstruction and excessive predation with adequate water quantity to allow for juvenile and adult mobility; cover, shelter, and holding areas for juveniles and adults; and adequate water quality to allow for survival.

(4) **Estuarine areas** that provide uncontaminated water and substrates; food and nutrient sources to support growth and development; and connected shallow water areas and wetlands to cover juveniles.

(5) **Marine areas** with sufficient water quality to support salmonid growth, development, and mobility; food and nutrient resources such as marine invertebrates and forage fish; and nearshore marine habitats with adequate depth, cover, and marine vegetation to provide cover and shelter.

The CHART indicated in their review (NMFS 2005b) that the Sacramento Delta sub-basin encompasses an area of approximately 446 square miles with 355 miles of stream channels. Of this, fish distribution and habitat use occur in approximately 194 miles of occupied riverine/estuarine habitat for CV steelhead and 180 miles for the CV spring-run Chinook salmon. The CHART concluded that these occupied areas contained one or more PCEs (*i.e*. freshwater rearing and migratory habitat and estuarine areas) and described the Sacramento Delta as having a high conservation value, primarily due to its use as a rearing and migratory corridor for listed spring-run Chinook salmon and steelhead and in the Central Valley.

The river channel within the action area is primarily used as a migratory corridor by CV spring-run Chinook salmon and CV steelhead moving into and out of the Sacramento River watershed. These fish move through the Sacramento River and Delta to the lower reaches of the Delta and the marine waters beyond. Due to the loss of riparian habitat and tidal flats resulting from decades of dredging and riprapping, the ecological value of the lower Sacramento River as a rearing habitat has been greatly diminished from historical conditions, although rearing is still considered to occur in the lower river and delta. The CHART has determined that the waterways of the Sacramento Delta are necessary for connecting the freshwater spawning habitats upstream in the Sacramento River watershed with the downstream waterways leading to the ocean and thus have a high conservation value. The project itself will not significantly diminish the value of the waterway as a migratory corridor compared to its current condition. The dredging activities (dredging, dredged material disposal, and bank stabilization) should not cause acute conditions that will lead to direct mortality of fish or create an impassable barrier. If such conditions were to occur, the discharge would be out of compliance with state and federal water quality laws, and thus any take of fish occurring due to these violations or subsequent loss of aquatic habitat would not be subject to the conditions of this biological opinion and its incidental take statement. Incidental take of listed species can only be given for lawful actions.

The long-term effects of bank stabilization activities will be to maintain the currently channelized and riprapped conditions characterizing the banks of the SDWSC. These conditions will be periodically worsened as the limited riparian vegetation that may be present is removed to facilitate replacement of riprap. In general, the SDWSC will continue to provide relatively uniform, deep, open habitat that lacks the suitable shallow water resting, sheltering, and feeding locations which characterize the freshwater rearing sites (a PCE of critical habitat) on which juvenile steelhead and other salmonids depend for adequate growth and protection from predators. The reduction in shade may contribute to elevated water temperatures in the upper section of the SDWSC, but this should not be of great concern because listed juvenile salmonids are not expected to be present in this reach. Green sturgeon may be less affected by these conditions as they tend to occupy deep pools. Although the proposed action will prevent the Sacramento River from reestablishing natural hydrological conditions and characteristics, it is not anticipated to further degrade an already highly degraded system. The critical habitat baseline is not anticipated to change significantly from the currently proposed action.

VIII. CONCLUSION

After reviewing the best available scientific and commercial information; the current status of SR winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the southern DPS of North American green sturgeon; the environmental baseline; the effects of the proposed SDWSC Maintenance Dredging and Bank Stabilization project; and the cumulative effects; it is NMFS's biological opinion that the SDWSC Dredging and Bank Stabilization project, as proposed, is not likely to jeopardize the continued existence of SR winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, or the southern DPS of North American green sturgeon, or result in the destruction or adverse modification of the designated critical habitat for SR winter-run Chinook salmon, CV spring-run Chinook salmon, or CV steelhead.

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS as an act which kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement (ITS).

The measures described below are non-discretionary and must be undertaken by the Corps so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered in this ITS. If the Corps: (1) fails to assume and implement the terms and conditions of the ITS; and/or (2) fails to require the agents of the Corps to adhere to the terms and conditions of the ITS through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps and the Corp's agents must report the progress of the action and its impact on the species to NMFS as specified in this ITS (50 CFR §402.14[i][3]).

Although some measures described below are expected and intended to avoid, minimize, or monitor the take of North American green sturgeon, the section 9 prohibitions against taking of listed species and the terms and conditions of the incidental take statement in this biological opinion will not apply to North American green sturgeon until the final section 4(d) ruling under the ESA has been published in the Federal Register.

A. Amount or Extent of Take

NMFS anticipates that the proposed SDWSC Maintenance Dredging project and the associated shipping activities will result in the incidental take of SR winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and North American green sturgeon. The incidental take is expected to be in the form of death, injury, harassment, and harm from sources such as turbidity and contaminant resuspension, entrainment in the dredge, exposure to DMP effluent, and altered habitat conditions. Direct take of salmonids from the Corps' dredging activities (*e.g.*, entrainment in the dredge or exposure to resuspended contaminants) is expected to occur primarily to adult and juvenile CV steelhead, juvenile Sacramento winter-run Chinook salmon, and yearling CV spring-run Chinook salmon during the period from September 1 through November 30, when the start of winter rains may trigger the migration of a small number of fish through the lowermost 18.6 miles of the SDWSC. Take from exposure to the DMP effluent may occur through January. Take from long-term impacts or changes to the action area (*e.g.*, loss of shallow water and riparian habitat in areas of bank stabilization) is expected to affect listed salmonids the entire period when individuals from one or more of the listed ESUs or DPSs may be expected to occur in the action area, but because these activities will occur only in the upper, manmade portion of the SDWSC, few individuals are expected to be exposed.

NMFS assumes that like Chinook salmon and steelhead, North American green sturgeon are most likely to occur in the lowermost 18.6 miles of the SDWSC which is part of their major migration route. Green sturgeon are expected to occur in the action area year-round, although in greater numbers from April through October. Therefore, take from project activities is most likely to occur from June through October, due to overlap with the proposed work window. The occupation of benthic habitat by green sturgeon is expected to increase their vulnerability to entrainment by the dredge cutterhead compared to listed salmonids.

The numbers of SR winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and North American green sturgeon taken will be difficult to quantify because dead, injured, or impaired individuals will be difficult to detect and recover. Take is expected to include:

1. All SR winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and North American green sturgeon juveniles harmed, harassed, or killed from altered habitat conditions caused by the maintenance dredging of the SDWSC or stabilization of the levee system along the SDWSC. Such conditions may include loss of benthic organism diversity, loss of riparian and shallow water habitat, reduced growth rate, or increased predation risk. Altered habitat is not expected to exceed the footprint of the maintenance dredging or bank stabilization project area as described in the project description included in the BA. Annual values will change according to the needs determination made by the Corps each year. All bank stabilization work is limited to the upper section of the SDWSC (*i.e.*, upstream of Cache Slough); inwater work is limited to the period from June 15 through September 30.

2. All SR winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and North American green sturgeon juveniles and adults that are harmed or killed from exposure to contaminants resuspended during the maintenance dredging action, and the subsequent discharging of decant water from DMP sites located along the SDWSC that receive the dredge spoils. NMFS anticipates that take of listed salmonids, whether in the form of mortality or morbidity, will occur from contaminant resuspension. The anticipated level of contaminant-related mortality is expected to be higher than the mortalities incurred from habitat effects. However, except for the month of November, it is anticipated that very few listed salmonids will be present during the dredging work window for the lowermost 18.6 miles of the SDWSC (June 1 through November 30) based on salmon monitoring activities conducted by the CDFG and USFWS in the Sacramento River and Delta for winter-run and spring-run Chinook salmon. Take may be estimated from the initial zone of dilution for each DMP site outfall (300 feet total length up and downstream from the outfall and not to exceed 50 percent of the cross-section of the receiving water body outwards from the bank). As estimated in subheading (1) above, the average number of winter-run sized Chinook salmon that may potentially be exposed to the decant effluent during the 3 months between September and November is approximately 3,379 fish of which 2 percent are expected to suffer morbidity and mortality (68 fish). Based on the same reasoning, approximately 200 spring-run sized Chinook salmon would be exposed in late November. Of these exposed fish, 2 percent are expected to suffer morbidity or mortality from the dredging action’s discharge of decant waters from the DMP sites (4 fish). NMFS recently completed a conference opinion assessing the impacts of the IEP fish sampling activities on North American green sturgeon (NMFS 2005c). A total of 265 juvenile or adult North American green sturgeon are anticipated to be taken by 4 of 15 fisheries-related studies. One of the

studies involves year-round sampling; most of the take is expected to occur from April through October and, therefore, greatly overlaps with the dredging activities proposed for the lower portion of the SDWSC. In the absence of definitive data, NMFS estimates that the number of North American green sturgeon taken by the proposed activities in the SDWSC will be equal to the IEP take. Therefore, annual incidental take is estimated to be 265 juvenile, sub-adult, or adult North American green sturgeon per year, of which 2 percent are expected to suffer morbidity and mortality (6 fish).

3. All North American green sturgeon juveniles that are harmed or killed from entrainment into the hydraulic dredge during its operation. All fish entrained are expected to suffer 100 percent mortality, as they will end up in the DMP site following entrainment. Incidental take of juvenile North American green sturgeon is expected to be relatively high (*i.e.*, 10 percent of those exposed) due to their benthic orientation, which will make direct exposure to the dredge cutterhead likely. Annual incidental take of juvenile North American green sturgeon is not expected to exceed 5 fish, based on the expected take of juveniles by the IEP fish sampling activities (NMFS 2005c).

B. Effect of the Take

In the accompanying biological and conference opinion, NMFS determined that the level of anticipated take will not result in jeopardy to the species or destruction or adverse modification of designated critical habitat.

C. Reasonable and Prudent Measures

Pursuant to section 7(b)(4) of the ESA, the following reasonable and prudent measures are necessary and appropriate to minimize take of SR winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and North American green sturgeon.

1. Measures shall be taken to avoid, minimize, and monitor the impacts of maintenance dredging upon listed salmonids, North American green sturgeon, and their habitat.

2. Measures shall be taken to avoid, minimize, and monitor the impacts of bank stabilization activities upon listed salmonids, North American green sturgeon, and their habitat.

3. Measures shall be taken to monitor the impacts to listed North American green sturgeon from entrainment into the hydraulic dredge during its operation

D. Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, the action must be implemented in compliance with the following terms and conditions, which implement the reasonable and prudent measures described above for each category of activity. These terms and conditions are non-discretionary.

1. Measures shall be taken to avoid, minimize, and monitor the impacts of maintenance dredging upon listed salmonids, North American green sturgeon, and their habitat.

a) Dredging operations shall be conducted within the specified work window of June 1 through February 27 and dredging from December 1 through February 27 shall be conducted only in the upper section of the SDWSC that is located outside of the Sacramento River and Cache Slough. If dredging is necessary outside of this window, NMFS will be contacted for approval at least 30 days prior to the activity. The request must be written and include the location and size of the work area within the SDWSC, and estimates of the amount of time required and dredging material to be removed. The request is to be sent to the following address:

Attn: Supervisor
National Marine Fisheries Service
650 Capitol Mall, Suite 8-300
Sacramento, California 95814-4706

Office: (916) 930-3601
Fax: (916) 930-3629

b) Maintenance dredging conducted outside of the specified work window of June 1 through February 27, and restricted to the upper section of the SDWSC for the period from December 1 through February 27, may require the following additional protective measures:

i) Silt curtains may be employed to surround the dredging area to prevent the spread of suspended sediments into the migration corridor of SR winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and North American green sturgeon.

ii) The Corps will be required to visually monitor the waterway adjacent to the dredge area (*i.e.*, within 300 feet) for any affected fish including, but not limited to, SR winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and North American green sturgeon. Observation of one or more affected fish will be reported to NMFS at the address above within 24 hours of the incident. The Corps will coordinate with NMFS to determine the cause of the incident and whether any additional protective measures are necessary to protect listed salmonids and North American green sturgeon. These protective measures shall be implemented within 72 hours of the incident. Affected fish are defined as:

(1) Dead or moribund fish at the water surface;
(2) Show signs of erratic swimming behavior or other obvious signs of distress;
(3) Gasping at the surface; or
(4) Show signs of other unusual behavior.

c) Maintenance dredging shall be implemented exactly as described in the BA and supplemental information package received by NMFS, and summarized in this biological opinion, including implementation of all applicable conservation measures listed in this biological opinion. NMFS shall be notified in advance of any proposed changes to determine if reinitiation of consultation or implementation of additional protective measures for fish may be necessary. Prior to each dredging season, the Corps shall provide NMFS documentation of exact reaches of the SDWSC proposed for maintenance dredging, schedules for that dredging year, and which DMP sites are to be used. At the completion of each dredging season, the Corps shall provide NMFS documentation of the exact reaches of the SDWSC that were dredged, and which DMP sites were used. Also, NMFS shall be sent copies of any sediment, effluent, or water quality monitoring reports required by the Regional Board that are related to the dredging actions of this project at the address above within 60 days of their completion.

d) Final drafts of the Corps' proposed plans for fisheries monitoring and water quality monitoring programs shall be completed prior to the start of the 2007 maintenance dredging season, and will include adaptive management strategies. All activities related to scope identification (*i.e.*, goals, milestones for completion, check-in points, triggers for management change (management decision points that include specific metrics), and sampling/testing protocols to be developed) will be coordinated with NMFS.

2. Measures shall be taken to avoid, minimize, and monitor the impacts of bank stabilization activities upon listed salmonids, North American green sturgeon, and their habitat.

a) Bank stabilization activities shall be implemented exactly as described in the BA and supplemental information package received by NMFS, and summarized on pages 5 through 6 of this biological opinion, including implementation of all applicable conservation measures listed on pages 6 through 9 of this biological opinion. NMFS shall be notified in advance of any proposed changes to determine if reinitiation of consultation or implementation of additional protective measures for fish may be necessary.

b) The conceptual models of the Standard Assessment Methodology (SAM; Corps 2004) shall be applied to the proposed action to design specific bank stabilization activities that will minimize impacts to listed species. The SAM was developed by the Corps, in collaboration with NMFS, the California Department of Fish and Game, the California Department of Water Resources, and the U.S. Fish and Wildlife Service, to quantify impacts to listed fish species and their habitat from large bank protection projects. The SAM represents the best available scientific approach for assessing the effects of bank protection actions to listed anadromous fish and their habitat.

3. Measures shall be taken to monitor the impacts to listed North American green sturgeon from entrainment into the hydraulic dredge during its operation.

a) The Corps will monitor take of green sturgeon, and if necessary within 5 years develop methodologies to reduce or eliminate the entrainment of green sturgeon during hydraulic dredging operations. Such methodology may be in the form of exclusion devices similar to turtle boxes, or wire "ticklers" to move fish away from the cutterhead. The Corps will work with NMFS to develop and test these devices.

b) The Corps will monitor take of green sturgeon, and if necessary within 5 years will study the potential for sediment contaminants to affect benthic-oriented fish such as sturgeon. Such studies will examine direct exposures, such as through dermal contact or ingestion, or indirect exposure through the forage base.

X. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on a listed species or critical habitat or regarding the development of pertinent information.

1. The Corps should support and promote aquatic and riparian habitat restoration within the Sacramento River and Delta region, and encourage its contractors to modify operation and maintenance procedures through the Corps' authorities so that those actions avoid or minimize negative impacts to salmon and steelhead.

2. The Corps should support anadromous salmonid monitoring programs throughout the Sacramento River and Delta to improve the understanding of migration and habitat utilization by salmonids in this region.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

XI. REINITIATION OF CONSULTATION

This concludes formal consultation on the proposed SDWSC Maintenance Dredging and Bank Protection project. Reinitiation of formal consultation is required if: (1) the amount or extent of taking specified in any incidental take statement is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the action, including the avoidance, minimization, and compensation measures listed in the *Description of the Proposed Action* section is subsequently modified in a manner that causes an effect to the listed species that was not considered in the biological opinion; or (4) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

XII. LITERATURE CITED

Allen, K.O. and J.W. Hardy. 1980. Impacts of navigational dredging on fish and wildlife: a literature review. Office of Biological Sciences, Fish and Wildlife Service. Washington D.C.

Arkoosh, M.R., Clemons, E., Myers, M. and Casillas, E. 1994. Suppression of B-Cell mediated immunity in juvenile chinook salmon (*Oncorhynchus tshawytscha*) after exposure to either a polycyclic aromatic hydrocarbon or to polychlorinated biphenyls. *Immunopharmacology and Immunotoxicology*: Vol. 16, No. 2, 293-314.

Arkoosh, M.R., E. Casillas, E. Clemons, A.N. Kagley, R. Olson, and P. Reno. 1998. Effect of pollution on fish diseases: potential impacts to salmonid populations. J. Aquat. Anim. Health. 10: 182-190.

Ayers and Associates. 2001. Two-dimensional modeling and analysis of spawning bed mobilization, lower American River. Prepared for U.S. Army Corps of Engineers, Sacramento District Office.

Bailey, E.D. 1954. Time pattern of 1953-1954 migration of salmon and steelhead into the upper Sacramento River. California Department of Fish and Game, unpublished report.

Barnhart, R.A. 1986. Species Profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest), steelhead. U.S. Fish and Wildlife Service Biological Report 82(11.60).

Beamer, E.M., and R.A. Henderson. 1998. Juvenile Salmonid Use of Natural and Hydromodified Streambank Habitat in the Mainstem Skagit River, Northwest Washington. Corps of Engineers, Seattle District. Seattle Washington, September 1998.

Beamesderfer, R., M. Simpson, G. Kopp, J. Inman, A. Fuller, and D. Demko. 2004. Historical and current information on green sturgeon occurrence in the Sacramento and San Joaquin Rivers and tributaries. Prepared for State Water Contractors by S.P. Cramer and Associates, Inc., Gresham, Oregon. 46 pages.

Bell, M.C. 1991. Fisheries Handbook of Engineering Requirements and Biological Criteria (third edition). U.S. Army Corps of Engineers, Portland, Oregon.

Berg, L., and T.G. Northcote. 1985. Changes in territorial, gill-flaring, and feeding behavior in juvenile coho salmon (*Oncorhynchus kisutch*) following short-term pulses of suspended sediment. Can. J. Fish. Aquat. Sci. 42: 1410-1417.

Bilby R.E. 1984. Removal of woody debris may affect stream channel stability. Journal of Forestry 82:609-613.

Bisson, P.A., and R.E. Bilby. 1982. Avoidance of suspended sediment by juvenile coho salmon. N. Am. J. Fish. Manage. 4: 371-374.

Boles, G.L., S.M. Turek, C.C. Maxwell, and D.M. McGill. 1988. Water temperature effects on Chinook salmon (*Oncorhynchus tshawytscha*) with emphasis on the Sacramento River: a literature review. California Department of Water Resources.

Bolton, S., and J. Shellberg. 2001. Ecological Issues in Floodplains and Riparian Corridors. White Paper - Aquatic Habitat Guidelines. Washington Department of Fish and Wildlife, Washington Department of Ecology, and Washington Department of Transportation, Olympia, Washington 2001.

Bureau of Reclamation and Orange Cove Irrigation District. 1999. Draft Environmental Assessment/Initial Study for Mill Creek Anadromous Fish Adaptive Management Enhancement Plan. August 1999.

Busby, P.J., T.C. Wainwright, G.J. Bryant, L. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon and California. U.S. Department of Commerce. NOAA Technical Memo. NMFS-NWFSC-27.

California Advisory Committee on Salmon and Steelhead Trout. 1998. Restoring the balance. California Department of Fish and Game, Inland Fisheries Division, Sacramento, California, 84 pages.

CALFED Bay-Delta Program. 1999. Ecosystem Restoration Program Plan, Volume II. Technical Appendix to draft PEIS/EIR. June 1999.

California Department of Fish and Game. 1965. California Fish and Wildlife Plan.

California Department of Fish and Game. 1998. A report to the Fish and Game Commission: A status review of the spring-run Chinook (*Oncorhynchus tshawytscha*) in the Sacramento River drainage. Candidate Species Status Report 98-01. June 1998.

California Department of Fish and Game. 2001. Sacramento River Winter-run Chinook Salmon, Biennial Report 2000-2001, Prepared for the Fish and Game Commission.

California Department of Fish and Game. 2002. Sacramento River winter-run Chinook salmon biennial report, 2000-2001. Prepared for the Fish and Game Commission. California Department of Fish and Game, Habitat Conservation Division, Native Anadromous Fish and Watershed Branch.

California Department of Fish and Game. 2002a. California Department of Fish and Game comments to National Marine Fisheries Service regarding green sturgeon listing. 45 pages.

California Department of Fish and Game. 2003. Preliminary unpublished data: Adult Chinook salmon populations in the Sacramento/San Joaquin River systems. Native Anadromous Fish and Watershed Branch. Sacramento, California.

California Department of Fish and Game. 2004a. Preliminary unpublished data: Adult Chinook salmon populations in the Sacramento/San Joaquin River systems. Native Anadromous Fish and Watershed Branch. Sacramento, California.

California Department of Fish and Game. 2004b. Freshwater Sport Fishing Regulations 2004-2006. California Fish and Game Commission and Department of Fish and Game. Sacramento, California.

California Department of Fish and Game. 2004c. Grand Tab. Native Anadromous Fish and Watershed Branch. Sacramento, California.

California Department of Water Resources. 2002. Sacramento Deep Water Ship Channel Fish Passage Facilities Project Plan. Ecological Services Office, Sacramento, CA.

California Resources Agency. 1989. Upper Sacramento River Fisheries and Riparian Management Plan. Prepared by an Advisory Council established by SB1086, authored by State Senator Jim Nielson.

Campbell, E.A., and P. B. Moyle. 1992. Effects of temperature, flow, and disturbance on adult spring-run Chinook salmon. University of California. Water Resources Center. Technical Completion Report.

Carlson, T.J., G.R. Ploskey, R.L. Johnson, R.P. Mueller, M.A. Weiland and P.N. Johnson. 2001. Observations of the behavior and distribution of fish in relation to the Columbia River navigation channel and channel maintenance activities. Pacific Northwest National Laboratory, Richland, WA.

Clark, G.H. 1929. Sacramento-San Joaquin salmon (*Oncorhynchus tshawytscha*) fishery of California. California Department of Fish and Game Bulletin 17:73.

Cordone, A.J., and D.W. Kelley. 1961. The influences of inorganic sediment on the aquatic life of streams. California Department of Fish Game 47:189-228.

Daughton, C.G. 2003. Cradle-to-cradle stewardship of drugs for minimizing their environmental disposition while promoting human health. I. Rationale for and avenue toward a green pharmacy. Environmental Health Perspectives 111:757-774.

Decato, R.J. 1978. Evaluation of the Glenn-Colusa Irrigation District Fish Screen. California Department of Fish and Game, Anadromous Fish Branch Administrative Report No. 78-20.

Deng, X., J.P. Van Eenennaam, and S.I. Doroshov. 2002. Comparison of early life stages and growth of green sturgeon and white sturgeon. Pages 237-248 *in* W. Van Winkle, P.J. Anders, D.H. Secor, and D.A. Dixon, editors. Biology, management, and protection of North American sturgeon. American Fisheries Society, Symposium 28, Bethesda, Maryland.

Dubrovsky, N.M., C.R. Kratzer, L.R. Brown, J.M. Gronberg, and K.R. Burow. 2000. Water quality in the San Joaquin-Tulare basins, California, 1992-95. U.S. Geological Survey Circular 1159.

Dubrovsky, N.M., D.L. Knifong, P.D. Dileanis, L.R. Brown, J.T. May, V. Connor, and C.N. Alpers. 1998. Water quality in the Sacramento River basin. U.S. Geological Survey Circular 1215.

Edwards, G.W., K.A.F. Urquhart, and T.L. Tillman. 1996. Adult salmon migration monitoring, Suisun Marsh Salinity Control Gates, September-November 1994. Technical Report 50. Interagency Ecological Program for the San Francisco Bay/Delta Estuary.

Emmett, R.L., S.L. Stone, S.A. Hinton, and M.E. Monaco. 1991. Distribution and abundance of fishes and invertebrates in West coast estuaries, Volume II: Species life history summaries. ELMR Report No. 8. NOAA/NOS Strategic Environmental Assessments Division, Rockville, Maryland.

Erickson, D.L., J.A. North, J.E. Hightower, J. Weber, L. Lauck. 2002. Movement and habitat use of green sturgeon *Acipenser medirostris* in the Rogue River, Oregon, USA. Journal of Applied Ichthyology 18:565-569.

Ewing, R.D. 1999. Diminishing Returns: Salmon Decline and Pesticides. Oregon Pesticide Education Network. http://www.pond.net/~fish1ifr/salpest.pdf.

Fisher, F.W. 1994. Past and Present Status of Central Valley Chinook Salmon. Conservation Biology 8:870-873.

Gadomski, D.M., and M.J. Parsely. 2005. Effects of turbidity, light level, and cover on predation of white sturgeon larvae by prickly sculpins. Transactions of the American Fisheries Society 134:369-374.

Garcia, A. 1989. The impacts of squawfish predation on juvenile Chinook salmon at Red Bluff Diversion Dam and other locations in the Sacramento River. U.S. Fish and Wildlife Service, Report No. AFF/FAO

Gingras, M. 1997. Mark/recapture experiments at Clifton Court Forebay to estimate pre-screen loss of juvenile fishes: 1976-1993. Interagency Ecological Program Technical Report No. 55.

Goals Project. 1999. Baylands Ecosystem Habitat Goals: A report of habitat recommendations prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. A report of habitat recommendations prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. USEPA, San Francisco. San Francisco Bay Regional Water Quality Control Board, Oakland, California.

Good, T.P., R.S. Waples, and P. Adams (editors). 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-66, 598 p.

Gregory, R.S., and T.S. Northcote. 1993. Surface, planktonic, and benthic foraging by juvenile chinook salmon (Oncorhynchus tshawytscha) in turbid laboratory conditions. Can. J. Fish. Aquat. Sci. 50: 223-240.

Hallock, R.J., D.H. Fry, and D.A. LaFaunce. 1957. The use of wire fyke traps to estimate the runs of adult salmon and steelhead in the Sacramento River. California Fish and Game 43:271-298.

Hallock, R.J., and W.F. Van Woert. 1959. A survey of fish losses in irrigation diversions from the Sacramento and San Joaquin Rivers. California Department of Fish and Game, Inland Fisheries Branch. Vol. 45 No. 4.

Hallock, R.J., W.F. Van Woert, and L. Shapovalov. 1961. An evaluation of stocking hatchery reared steelhead rainbow (*Salmo gairdnerii gairdnerii*) in the Sacramento River system. California Department of Fish and Game Bulletin 114.

Hallock, R.J., and F. Fisher. 1985. Status of winter-run Chinook salmon, *Oncorhynchus tshawytscha*, in the Sacramento River. California Department of Fish and Game, Anadromous Fisheries Branch Office Report. January 25, 1985.

Harrell, W.C., and T.R. Sommer. 2003. Patterns of Adult Fish Use on California's Yolo Bypass Floodplain. Pages 88-93 *in* P.M. Faber, editor. California riparian systems: Processes and floodplain management, ecology, and restoration. 2001 Riparian Habitat and Floodplains Conference Proceedings, Riparian Habitat Joint Venture, Sacramento, California

Hartman, G., J.C. Scrivener, L.B. Holtby, and L. Powell. 1987. Some effects of different streamside treatments on physical conditions and fish population processes in Carnation Creek, a coastal rainforest stream in British Columbia. Pages 330-372 *in* Salo and Cundy (1987).

Harvey, C.D. 1995. Adult steelhead counts in Mill and Deer Creeks, Tehama County, October 1993 - June 1994. California Department of Fish and Game. Inland Fisheries Administrative Report. No. 95-3.

Herren, J.R., and S.S. Kawasaki. 2001. Inventory of water diversions in four geographic areas in California's Central Valley. Pages 343-355 *in*: R.L. Brown, editor. Contributions to the biology of Central Valley salmonids. Volume 2. California Fish and Game. Fish Bulletin 179.

Interagency Ecological Program Steelhead Project Work Team. 1999. Monitoring, Assessment, and Research on Central Valley Steelhead: Status of Knowledge, Review Existing Programs, and Assessment Needs. *In:* Comprehensive Monitoring, Assessment, and Research Program Plan, Technical Appendix VII-11.

Jones and Stokes Associates, Inc. 1993. Strategies, potential sites, and site evaluation criteria for restoration of Sacramento River fish and wildlife habitats, Red Bluff to the Feather River. Prepared for the U.S. Army Corps of Engineers, Sacramento, California.

Keller, E.A., and F.J. Swanson. 1979. Effects of large organic material on channel form and fluvial processes. Earth Surface Processes 4:361-380.

Kjelson, M.A., P.F. Raquel, and F.W. Fisher. 1982. Life history of fall-run juvenile Chinook salmon, *Oncorhynchus tshawytscha,* in the Sacramento-San Joaquin estuary, California, pages 393-411 *in* V.S. Kennedy, editor. Estuarine comparisons. Academic Press, New York, New York.

Knudsen, E.E., and S.J. Dilley. 1987. Effects of Rip-rap Bank Reinforcement on Juvenile Salmonids in Four Western Washington Streams. North American Journal of Fisheries Management 7:351-356.

Kynard, B., E. Parker, and T. Parker. 2005. Behavior of early life intervals of Klamath River green sturgeon, *Acipenser medirostris*, with note on body color. Environmental Biology of Fishes 72:85-97.

Li, H.W., C.B. Schreck, and R.A. Tubb. 1984. Comparison of Habitats near Spur Dikes, Continuous Revetments, and Natural Banks for Larval, Juvenile, and Adult Fishes of the Willamette River. Oregon Cooperative Fishery Research Unit Department of Fisheries and Wildlife, Oregon State University. Water Resources Research Institute, Oregon State University, Corvallis, Oregon.

Mackay, R.J. 1992. Colonization by lotic macroinvertebrates: a review of processes and patterns. Can. J. Aquat. Sci. 49: 617-628.

Martin, C.D., P.D. Gaines, and R.R. Johnson. 2001. Estimating the abundance of Sacramento River juvenile winter Chinook salmon with comparisons to adult escapement. Red Bluff Research Pumping Plant Report Series, Volume 5. U.S. Fish and Wildlife Service, Red Bluff, California.

Mayfield, R.B. and J.J. Cech, Jr. 2004. Temperature Effects on green sturgeon bioenergetics. Transactions of the American Fisheries Society 133:961-970.

McEwan, D.R., and T. Jackson. 1996. Steelhead Restoration and Management Plan for California. California Department of Fish and Game, February 1996.

McEwan, D.R. 2001. Central Valley Steelhead. Contributions to the biology of Central Valley salmonids. R. Brown editor. California Department of Fish and Game Fish Bulletin No. 179.

McGill, R.R., Jr. 1987. Land use changes in the Sacramento River riparian zone, Redding to Colusa. A third update: 1982-1987. Department of Water Resources, Northern District.

Meehan, W.R., and T.C. Bjornn. 1991. Salmonid distribution and life histories. American Fisheries Society Special Publication 19:47-82.

Michny, F., and M. Hampton. 1984. Sacramento River Chico Landing to Red Bluff Project, 1984 juvenile salmon study. U.S. Fish and Wildlife Service, Division of Ecological Services, Sacramento, California.

Michny, F., and R. Deibel. 1986. Sacramento River Chico Landing to Red Bluff Project 1985 Juvenile Salmon Study. U.S. Fish and Wildlife Service and U.S. Army Corps of Engineers, Sacramento, California.

Moore, A., and C.P. Waring. 1996. Sublethal effects of the pesticide Diazanon on olfactory function in mature male Atlantic salmon parr. J. Fish. Biol. 48: 758-775.

Moyle, P. B. 1976. Inland fishes of California. University of California Press, Berkeley.

Moyle, P.B., J.E. Williams, and E.D. Wikramanayake. 1989. Fish species of special concern of California. Wildlife and Fisheries Biology Department, University of California, Davis. Prepared for The Resources Agency, California Department of Fish and Game, Rancho Cordova.

Moyle, P.B., P.J. Foley, and R.M. Yoshiyama. 1992. Status of green sturgeon, *Acipenser medirostris*, in California. Final report submitted to National Marine Fisheries Service, Terminal Island, California. 11 pages. University of California, Davis.

Moyle, P.B. 2002. Inland fishes of California. University of California Press, Berkeley.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memo. NMFS-NWFSC-35. 443 pages.

National Marine Fisheries Service. 1996. Factors for steelhead decline: a supplement to the notice of determination for west coast steelhead under the Endangered Species Act. NMFS Protected Species Branch (Portland, Oregon) and Protected Species Management Division, Long Beach, California.

National Marine Fisheries Service. 1997. NMFS Proposed Recovery Plan for the Sacramento River Winter-run Chinook Salmon. National Marine Fisheries Service Southwest Region, Long Beach, California. August 1997.

National Marine Fisheries Service. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-NWFSC.

National Marine Fisheries Service. 2001. Biological Opinion for the Sacramento River Bank Protection Project, Contracts 42E and 42F. National Marine Fisheries Service Southwest Region, Long Beach, California.

National Marine Fisheries Service. 2002. Status Review for North American Green Sturgeon (*Acipenser medirostris*), June 2002. Biological review team, Santa Cruz Laboratory, Southwest Fisheries Science Center. 31 pages.

National Marine Fisheries Service. 2005. Green sturgeon (*Acipenser medirostris*) status review update, February 2005. Biological review team, Santa Cruz Laboratory, Southwest Fisheries Science Center. 31 pages.

National Marine Fisheries Service. 2005b. Final Assessment of the National Marine Fisheries Services's Critical Habitat Analytical Review Teams (CHARTs) for seven salmon and steelhead evolutionarily significant units (ESUs) in California. July 2005.

National Marine Fisheries Service. 2005c. Addendum to the Central Valley programmatic biological opinion for scientific research, northern and central coast biological opinion for scientific research, and conference opinion for the southern distinct population segment of North American green sturgeon. Memorandum for Scientific Research Permit No. 1440. November 29, 2005. 71 pages.

Newcombe, C.P., and J.O.T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management. 16:693-727.

Nightingale, B., and C.A. Simenstad. July 2001. Dredging Activities: Marine Issues. Research Project T1803, Task 35, Whitepaper. Found at: http://www.wa.gov/wdfw/hab/ahg/ahgwhite.htm

Nobriga, M., and P. Cadrett. 2003. Differences among hatchery and wild steelhead: evidence from Delta fish monitoring programs. Interagency Ecological Program for the San Francisco Estuary Newsletter 14:30-38.

North, J.A., L.C. Burner, B.S. Cunningham, R.A. Farr, T.A. Friesen, J.C. Harrington, H.K. Takata, and D.L. Ward. 2002. Relationships between Bank Treatment/Near Shore Development and Anadromous/Resident Fish in the Lower Willamette River. Annual Progress Report May 2000 - June 2001. Oregon Department of Fish and Wildlife. City of Portland-Bureau of Environmental Services, Portland, Oregon.

Orsi, J. 1967. Predation Study Report, 1966-1967. California Department of Fish and Game.

Peters, R.J., B.R. Missildine, and D.L. Low. 1998. Seasonal Fish Densities Near River Banks Treated with Various Stabilization Methods. U.S. Fish and Wildlife Service, Lacey, Washington.

Phillips, R.W., and H.J. Campbell. 1961. The embryonic survival of coho salmon and steelhead trout as influenced by some environmental conditions in gravel beds. Annual Report to Pacific Marine Fisheries Commission 14:60-73.

Pickard, A., A. Grover, and F. Hall. 1982. An Evaluation of predator composition at three locations on the Sacramento River. Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary. Technical Report No. 2.

Radtke, L.D. 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in the Sacramento-San Joaquin delta, Part II. Pp. 115-119. *In*: S.L. Turner and D.W. Kelley (eds.), California Fish and Game Bulletin 136.

Rand, G.M. Ed. 1995. Fundamentals of Aquatic Toxicology. Effects, Environmental Fate and Risk Assessment. Taylor and Francis, Washington, D.C. 1125p.

Reine, K., and D. Clarke. 1998. Entrainment by hydraulic dredges–A review of potential impacts. Technical Note DOER-E1. U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Reynolds, F.L., T.J. Mills, R. Benthin, and A. Low. 1993. Restoring Central Valley streams: a plan for action. California Department of Fish and Game, Inland Fisheries Division, Sacramento.

Rich, A.A. 1997. Testimony of Alice A, Rich Ph.D. regarding water rights applications for the Delta Wetlands Project, proposed by Delta Wetlands Properties for Water Storage on Webb Tract, Bacon Island, Bouldin Island, and Holland Tract in Contra Costa and San Joaquin Counties. July 1997. California Department of Fish and Game Exhibit CDFG-7. Submitted to State Water Resources Control Board.

Robison, G.E., and Beschta, R.L. 1990. Identifying trees in riparian areas that can provide coarse woody debris to streams. U.S. Forest Service 36:790-801.

Schaffter, R.G., P.A. Jones, and J.G. Karlton. 1983. Sacramento River and Tributaries Bank Protection and Erosion Control Investigation Evaluation of Impacts on Fisheries. California Department of Fish and Game. U.S. Army Corps of Engineers DACWO 5-80C-0110. Sacramento, California.

Schmetterling, D.A., C.G. Clancey, and T.M. Brandt. 2001. Effects of Riprap Bank Reinforcement on Stream Salmonids in the Western United States. Fisheries Vol. 26, No. 7 pp. 6-13.

Scholz, N.L., N.K. Truelove, B.L. French, B.A. Berejekian, T.P. Quin, E. Casillas, and T.K. Collier. 2000. Diazanon disrupts antipredator and homing behaviors in chinook salmon (*Oncorhynchus tshawytscha*). Can. J. Fish Aquat. Sci. 57:1911-1918.

Servizi, J.A., and D.W. Martens. 1987. Some effects of suspended Fraser River sediments on sockeye salmon (*Oncorhynchus nerka*), p. 254-264. In H. D. Smith, L. Margolis, and C. C. Wood [ed.] Sockeye salmon (*Oncorhynchus nerka*) population biology and future management. Can. Spec. Publ. Fish. Aquat. Sci. 96.

Servizi, J.A., and D.W. Martens. 1992. Sublethal responses of coho salmon (*Oncorhynchus kisutch*) to suspended sediments. Can. J. Fish. Aquat. Sci. 49: 1389-1395.

Shapovalov, L., and A.C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri gairdneri*) and silver salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. California Department of Fish and Game, Fish Bulletin 98.

Sigler, J.W., T.C. Bjornn, and F. H. Everest. 1984. Effects of chronic turbidity on density and growth of steelhead and coho salmon. Trans. Am. Fish. Soc. 113: 142-150.

Slater, D.W. 1963. Winter-run Chinook salmon in the Sacramento River, California with notes on water temperature requirements at spawning. Special Science Report No. 461.

Snider, B., and R.G. Titus. 2000. Timing, composition, and abundance of juvenile anadromous salmonid emigration in the Sacramento River near Knights Landing, October 1996-September 1997. California Department of Fish and Game, Habitat Conservation Division, Stream Evaluation Program Technical Report No. 00-04.

Staley, J.R. 1975. American River steelhead (Salmo gairdneri gairdneri) management, 1956-1974. California Department of Fish and Game, Region 2, Inland Fisheries, Anadromous Branch, Administrative Report No. 76-2.

Stevens, D.E. 1961. Food habits of striped bass, *Roccus saxitilis* (Walbaum), in the Rio Vista area of the Sacramento River. Master's Thesis, University of California, Berkeley.

Tillman, T.L., G.W. Edwards, and K.A.F. Urquhart. 1996. Adult salmon migration during the various operational phases of Suisun Marsh Salinity Control Gates in Montezuma Slough: August-October 1993. Agreement to Department of Water Resources, Ecological Services Office by California Department of Fish and Game, Bay-Delta and Special Water Projects Division.

U.S. Army Corps of Engineers, Sacramento District. 1995. Sacramento River Fish Migration Reconnaissance Report. Sacramento District, South Pacific Division.

U.S. Army Corps of Engineers, Sacramento District. 2003a. Notice of Intent to Conduct, Sacramento River Maintenance Dredging Project (River Miles 5.11-6.44, 8.24-8.43, and 30.45-33.52).

U.S. Army Corps of Engineers, Sacramento District. 2003b. Technical Specifications for 3-Year (2003-2005) Maintenance Dredging Contract (Indefinite Delivery Indefinite Quantity).

U.S. Department of Interior. 1999. Final Programmatic Environmental Impact Statement for the Central Valley Project Improvement Act. October 1999. Technical Appendix, 10 volumes.

U.S. Fish and Wildlife Service. 1995. Planning Aid Report for the Sacramento River Fish Migration Reconnaissance Study.

U.S. Fish and Wildlife Service. 1999. Effects of temperature on early-life survival of Sacramento River fall- and winter-run Chinook salmon. U.S. Fish and Wildlife Service Final Report.

U.S. Fish and Wildlife Service. 2000. Impacts of riprapping to ecosystem functioning, lower Sacramento River, California. U.S. Fish and Wildlife Service, Sacramento Field Office, Sacramento, California. Prepared for U.S. Army Corps of Engineers, Sacramento District.

U.S. Fish and Wildlife Service (USFWS). 2003. Abundance and Survival of Juvenile Chinook Salmon in the Sacramento-San Joaquin Estuary: 1999. Annual progress report Sacramento-San Joaquin Estuary.

Van Eenennaam, J.P., J. Linares-Casenave, X. Deng, and S.I. Doroshov. 2005. Effect of incubation temperature on green sturgeon embryos, *Acipenser medirostris*. Environmental Biology of Fishes 72:145-154.

Van Woert, W. 1958. Time pattern of migration of salmon and steelhead into the upper Sacramento River during the 1957-1958 season. Inland Fisheries Administrative Report 59-7.

Van Woert, W. 1964. Mill Creek counting station. Office memorandum to Eldon Hughes, May 25, 1964. California Department of Fish and Game, Water Projects Branch, Contract Services Section.

Vogel, D.A., K.R. Marine, and J.G. Smith. 1988. Fish passage action program for Red Bluff Diversion Dam. Final Report, U.S. Fish and Wildlife Service. Report No. FR1-FAO-88-19.

Vogel, D.A., and K.R. Marine. 1991. Guide to Upper Sacramento River Chinook salmon life history. Prepared for the U.S. Bureau of Reclamation, Central Valley Project.

Waples, R.S. 1991. Pacific Salmon, *Oncorhynchus spp*., and the definition of “species” under the Endangered Species Act. Marine Fisheries Review 53:11-21.

Waring, C.P., and A. Moore. 1997. Sublethal effects of a carbamate pesticide on pheromonal mediated endocrine function in mature male Atlantic salmon (*Salmo salar L*.) parr. Fish Physiology and Biochemistry 17: 203-211.

Waters, T.F. 1995. Sediment in streams: sources, biological effects, and control. American Fisheries Society Monograph 7. 251 pp.

Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher, and P.B Moyle. 1996. Historical and present distribution of Chinook salmon in the Central Valley Drainage of California. *In:* Sierra

Nevada Ecosystem Project, Final Report to Congress, volume III, Assessments, Commissioned Reports, and Background Information. University of California, Davis, Centers for Water and Wildland Resources.

Yoshiyama, R.M, F.W. Fisher, and P.B. Moyle. 1998. Historical abundance and decline of Chinook salmon in the Central Valley region of California. North American Journal of Fisheries Management 18:487-521

Enclosure 2

Magnuson-Stevens Fishery Conservation and Management Act

ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS

I. IDENTIFICATION OF ESSENTIAL FISH HABITAT

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended (U.S.C. 180 *et seq.*), requires that Essential Fish Habitat (EFH) be identified and described in Federal fishery management plans (FMPs). Federal action agencies must consult with the NOAA's National Marine Fisheries Service (NMFS) on any activity which they fund, permit, or carry out that may adversely affect EFH. NMFS is required to provide EFH conservation and enhancement recommendations to the Federal action agencies.

EFH is defined as those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purposes of interpreting the definition of EFH, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers all habitat types used by a species throughout its life cycle. The proposed project site is within the region identified as EFH for Pacific salmon in Amendment 14 of the Pacific Salmon FMP and for starry flounder (*Platichthys stellatus*) and English sole (*Parophrys vetulus*) in Amendment 11 to the Pacific Coast Groundfish FMP.

The Pacific Fishery Management Council (PFMC) has identified and described EFH, Adverse Impacts and Recommended Conservation Measures for salmon in Amendment 14 to the Pacific Coast Salmon FMP (PFMC 1999). Freshwater EFH for Pacific salmon in the California Central Valley includes waters currently or historically accessible to salmon within the Central Valley ecosystem as described in Myers *et al.* (1998), and includes the San Joaquin Delta (Delta) hydrologic unit (*i.e.*, number 18040003), Suisun Bay hydrologic unit (18050001) and the Lower Sacramento hydrologic unit (18020109). Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), and Central Valley fall-/late fall-run Chinook salmon (*O. tshawytscha*) are species managed under the Salmon Plan that occur in the Delta, Suisun Bay and Lower Sacramento units.

Factors limiting salmon populations in the Delta include periodic reversed flows due to high water exports (drawing juveniles into large diversion pumps), loss of fish into unscreened agricultural diversions, predation by introduced species, and reduction in the quality and quantity of rearing habitat due to channelization, pollution, rip-rapping, *etc*. (Dettman *et al.* 1987;

California Advisory Committee on Salmon and Steelhead Trout 1988, Kondolf *et al.* 1996a, 1996b). Factors affecting salmon populations in Suisun Bay include heavy industrialization within its watershed and discharge of waste water effluents into the bay. Loss of vital wetland habitat along the fringes of the bay reduce rearing habitat and diminish the functional processes that wetlands provide for the bay ecosystem.

A. Life History and Habitat Requirements

1. Pacific Salmon

General life history information for Central Valley Chinook salmon is summarized below. Information on Sacramento River winter-run and Central Valley spring-run Chinook salmon life histories is summarized in the preceding biological opinion for the proposed project (Enclosure 1). Further detailed information on Chinook salmon Evolutionarily Significant Units (ESUs) are available in the NMFS status review of Chinook salmon from Washington, Idaho, Oregon, and California (Myers *et al.* 1998), and the NMFS proposed rule for listing several ESUs of Chinook salmon (63 FR 11482).

Adult Central Valley fall-run Chinook salmon enter the Sacramento and San Joaquin Rivers from July through April and spawn from October through December (U.S. Fish and Wildlife Service (FWS) 1998). Chinook salmon spawning generally occurs in clean loose gravel in swift, relatively shallow riffles or along the edges of fast runs (NMFS 1997).

Egg incubation occurs from October through March (Reynolds *et al.* 1993). Shortly after emergence from their gravel nests, most fry disperse downstream towards the Delta and into the San Francisco Bay and its estuarine waters (Kjelson *et al.* 1982). The remaining fry hide in the gravel or station in calm, shallow waters with bank cover such as tree roots, logs, and submerged or overhead vegetation. These juveniles feed and grow from January through mid-May, and emigrate to the Delta and estuary from mid-March through mid-June (Lister and Genoe 1970). As they grow, the juveniles associate with coarser substrates along the stream margin or farther from shore (Healey 1991). Along the emigration route, submerged and overhead cover in the form of rocks, aquatic and riparian vegetation, logs, and undercut banks provide habitat for food organisms, shade, and protect juveniles and smolts from predation. These smolts generally spend a very short time in the Delta and estuary before entry into the ocean. Whether entering the Delta or estuary as fry or juveniles, Central Valley Chinook salmon depend on passage through the Sacramento-San Joaquin Delta for access to the ocean.

2. Starry Flounder

The starry flounder is a flatfish found throughout the eastern Pacific Ocean, from the Santa Ynez River in California to the Bering and Chukchi Seas in Alaska, and eastwards to Bathurst inlet in Arctic Canada. Adults are found in marine waters to a depth of 375 meters. Spawning takes place during the fall and winter months in marine to polyhaline waters. The adults spawn in shallow coastal waters near river mouths and sloughs, and the juveniles are found almost exclusively in estuaries. The juveniles often migrate up freshwater rivers, but are estuarine dependent. Eggs are broadcast spawned and the buoyant eggs drift with wind and tidal currents. Juveniles gradually settle to the bottom after undergoing metamorphosis from a pelagic larva to a demersal juvenile by the end of April. Juveniles feed mainly on small crustaceans, barnacle larvae, cladocerans, clams and dipteran larvae. Juveniles are extremely dependent on the condition of the estuary for their health. Polluted estuaries and wetlands decrease the survival rate for juvenile starry flounder. Juvenile starry flounder also have a tendency to accumulate many of the anthropogenic contaminants found in the environment.

3. <u>English Sole</u>

The English sole is a flatfish found from Mexico to Alaska. It is the most abundant flatfish in Puget Sound, Washington and is abundant in the San Francisco Bay estuary system. Adults are found in nearshore environments. English sole generally spawn during late fall to early spring at depths of 50 to 70 meters over soft mud bottoms. Eggs are initially buoyant, then begin to sink just prior to hatching. Incubation may last only a couple of days to a week depending on temperature. Newly hatched larvae are bilaterally symmetrical and float near the surface. Wind and tidal currents carry the larvae into bays and estuaries where the larvae undergo metamorphosis into the demersal juvenile. The young depend heavily on the intertidal areas, estuaries, and shallow near-shore waters for food and shelter. Juvenile English sole primarily feed on small crustaceans (*i.e.* copepods and amphipods) and on polychaete worms in these rearing areas. Polluted estuaries and wetlands decrease the survival rate for juvenile English soles. The juveniles also have a tendency to accumulate many of the contaminants found in their environment and this exposure manifests itself as tumors, sores, and reproductive failures.

II. PROPOSED ACTION

The proposed action is described in section II (*Description of the Proposed Action*) of the preceding biological opinion for endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon and Central Valley steelhead (*O. mykiss*), critical habitat for winter-run Chinook salmon and proposed critical habitat for spring-run Chinook salmon and Central Valley steelhead (Enclosure 1).

III. EFFECTS OF THE PROJECT ACTION

The effects of the proposed action on salmonid habitat (*i.e.* for fall-run Chinook salmon) are described at length in section V (*Effects of the Action*) of the preceding biological opinion, and generally are expected to apply to Pacific salmon EFH. The general contaminant effects on the quality of EFH for the two species of flatfish are expected to be similar to those for salmon but will result in a greater magnitude of exposure to the two flatfish species due to their benthic life history. Benthic dwelling flatfish will have direct contact with contaminated sediment and will ingest sediment as well as benthic invertebrates during their foraging activities. Both the starry flounder and the English sole will spend more time as juveniles rearing in the action area than the Chinook salmon smolts. Therefore, these fish species will have a greater duration of exposure to the contaminants of concern than the juvenile Chinook salmon, leading to greater levels of adverse effects to the individual organisms. Furthermore, as indicated by the reports by CDFG staff of sturgeon propeller entrainment following large vessel passage, the two species of flatfish are expected to encounter conditions leading to propeller entrainment and are assumed to have some level of mortality and morbidity associated with this encounter.

IV. CONCLUSION

Based on the best available information, NMFS believes that the proposed Sacramento Deep Water Ship Channel Maintenance Dredging and Bank Protection project may adversely affect EFH for Pacific salmon and groundfish during its operations.

V. EFH CONSERVATION RECOMMENDATIONS

NMFS recommends that terms and conditions 1a, b, and c, and 2a and b, from the biological opinion be adopted as EFH Conservation Recommendations for EFH in the action area. In addition, certain other conservation measures need to be implemented in the project area, as addressed in Appendix A of Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999). NMFS anticipates that implementing those conservation measures intended to minimize disturbance and sediment and pollutant inputs to waterways would benefit groundfish as well.

Riparian Habitat Management–In order to prevent adverse effects to riparian corridors, the U.S. Army Corps of Engineers (Corps) should:

- Maintain riparian management zones of appropriate width in the Sacramento River and watersheds that influence EFH;
- Reduce erosion and runoff into waterways within the project area; and
- Minimize the use of chemical treatments within the riparian management zone to manage nuisance vegetation along the levee banks.

Bank Stabilization–The installation of riprap or other streambank stabilization devices can reduce or eliminate the development of side channels, functioning riparian and floodplain areas and off channel sloughs. In order to minimize these impacts, the Corps should:

- Use vegetative methods of bank erosion control whenever feasible. Hard bank protection should be a last resort when all other options have been explored and deemed unacceptable;

- Determine the cumulative effects of existing and proposed bio-engineered or bank hardening projects on salmon EFH, including prey species before planning new bank stabilization projects; and

- Develop plans that minimize alterations or disturbance of the bank and existing riparian vegetation.

Wastewater/Pollutant Discharges–Water quality essential to salmon and their habitat can be altered when pollutants are introduced through surface runoff, through direct discharges of pollutants into the water, when deposited pollutants are resuspended (*e.g.*, from dredging or ship traffic), and when flow is altered. Indirect sources of water pollution in salmon habitat includes run-off from streets, yards, and construction sites. In order to minimize these impacts, the Corps should:

- Monitor water quality discharge following Central Valley Region of the California Regional Water Quality Control Board requirements from all discharge points;

- For those waters that are listed under Clean Water Act section 303 (d) criteria (*e.g.*, the Delta), work with State and Federal agencies to establish total maximum daily loads and develop appropriate management plans to attain management goals; and

- Establish and update, as necessary, pollution prevention plans, spill control practices, and spill control equipment for the handling and transport of toxic substances in salmon EFH (*e.g.*, oil and fuel, organic solvents, raw cement residue, sanitary wastes, *etc*.). Consider bonds or other damage compensation mechanisms to cover clean-up, restoration, and mitigation costs.

VI. STATUTORY REQUIREMENTS

Section 305 (b) 4(B) of the MSA requires that the Federal lead agency provide NMFS with a detailed written response within 30 days, and 10 days in advance of any action, to the EFH conservation recommendations, including a description of measures adopted by the lead agency for avoiding, minimizing, or mitigating the impact of the project on EFH (50 CFR §600.920[j]). In the case of a response that is inconsistent with our recommendations, the Corps must explain its reasons for not following the recommendations, including the scientific justification for any disagreement with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, or mitigate such effects.

VII. LITERATURE CITED

California Advisory Committee on Salmon and Steelhead Trout. 1998. Restoring the balance. California Department of Fish and Game, Inland Fisheries Division, Sacramento, California, 84 pages.

Dettman, D.H., D.W. Kelley, and W.T. Mitchell. 1987. The influence of flow on Central Valley salmon. Prepared by the California Department of Water Resources. Revised July 1987. 66 pages.

Healey, M.C. 1991. Life history of Chinook salmon. *In* C. Groot and L. Margolis (editors) Pacific salmon life histories, pages 213-393. University of British Columbia Press, Vancouver.

Kjelson, M.A., P.F. Raquel, and F.W. Fisher. 1982. Life history of fall-run juvenile Chinook salmon, *Oncorhynchus tshawytscha*, in the Sacramento-San Joaquin estuary, California. *In* V.S. Kennedy (editor), Estuarine comparisons, pages 213-393. Academic Press, New York, New York.

Kondolf, G.M., J C. Vick and T.M. Ramirez. 1996a. Salmon spawning habitat rehabilitation in the Merced, Tuolumne, and Stanislaus Rivers, California: an evaluation of project planning and performance. University of California Water Resources Center Report No. 90, ISBN 1-887192-04-2, 147 pages.

Kondolf, G.M., J.C. Vick and T.M. Ramirez. 1996b. Salmon spawning habitat on the Merced River, California: An evaluation of project planning and performance. Transactions of the American Fisheries Society 125:899-912.

Lister, D.B., and H.S. Genoe. 1970. Stream habitat utilization by cohabiting underyearlings of Chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) salmon in the Big Qualicum River, British Columbia. Journal of the Fisheries Research Board of Canada 27:1215-1224.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-35, 443 pages.

National Marine Fisheries Service. 1997. Proposed recovery plan for the Sacramento River winter-run Chinook salmon. National Marine Fisheries Service, Southwest Region, Long Beach, California, 288 pages plus appendices.

Pacific Fishery Management Council. 1999. Description and identification of essential fish habitat, adverse impacts and recommended conservation measures for salmon. Amendment 14 to the Pacific Coast Salmon Plan, Appendix A. Pacific Fisheries Management Council, Portland, Oregon.

Reynolds, F.L., T.J. Mills, R. Benthin and A. Low. 1993. Restoring Central Valley streams: A plan for action. California Department of Fish and Game, Sacramento, California, 129 pages.

U.S. Fish and Wildlife Service. 1998. Central Valley Project Improvement Act tributary production enhancement report. Draft report to Congress on the feasibility, cost, and desirability of implementing measures pursuant to subsections 3406(e)(3) and (e)(6) of the Central Valley Project Improvement Act. U.S. Fish and Wildlife Service, Central Valley Fish and Wildlife Restoration Program Office, Sacramento, California.